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Austin A. Armer

Elected as president of the American Society of Sugar Beet Technologists for the biennium 1956-57, was Austin A. Armer. Mr. Armer is agricultural engineer for the Spreckels Sugar Company and headquarters at Woodland, California. He is prominent in the industry for his many contributions toward the the rapid mechanization of sugar beet production.

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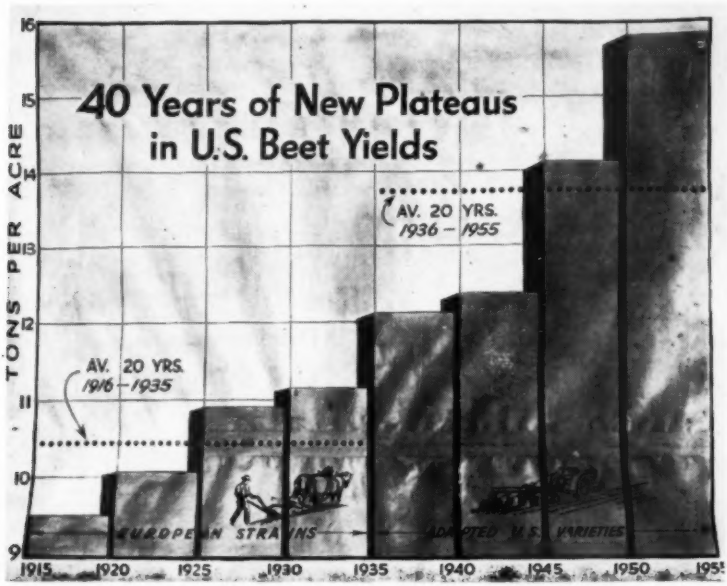
Old and New Plateaus

P. B. SMITH[1]

Just twenty years ago on January 31, a small group of men interested in sugar beet research sat down in what was then called "the second annual round-table discussions," in Fort Collins, Colorado. This group of 57 individuals formed the nucleus of your American Society of Sugar Beet Technologists which was formally started the next winter. From this small beginning has grown our present Society of 519 active members.

Largely through the efforts of members of our organization have come the tremendous advances that we have been privileged to see take place in the beet sugar industry. More progress has been made in the last twenty years than in all of the time since Achard recognized the commercial value of that wonderful plant of nature, the sugar beet, in Germany 170 years ago this year.

In no period of our sugar beet production record have we so much to boast about as in the progress obtained in the 1936 to 1955 period. For the 20-year period 1916 to 1935, when European varieties were used exclusively, the average beet yield was 10.4 tons per acre.[2] For the next 20-year period, 1936 to 1955, with American varieties coming into use, the yield was 13.7 tons. The difference is 3.3 tons, or a gain in yield of 31.7 percent.



[1] President, American Society of Sugar Beet Technologists, 1954-55; General Agriculturist, The Great Western Sugar Company; Vice President, Northern Ohio Sugar Company.
[2] U.S.D.A. Agricultural Statistics, 1942, p. 130; and Agricultural Statistics, 1954, p. 70.

You will note in the accompanying chart that the full effect of resistance to curly top and leaf spot and better-adapted American varieties was not shown until the last decade, 1946 to 1955. If you consider only the last five years, the average acre yield is 15.9 tons and the gain is 5½ tons, or 53 percent.

Let's go a little further in our analysis. The actual value of the increased yield per acre of the last twenty years over the first twenty years totals nearly 500 million dollars more for farmers. It has averaged $30.68 more for each acre harvested.

During the last twenty years, slightly more than eleven million dollars have been spent on agricultural research in sugar beets by U.S.D.A. state experiment stations, sugar companies and other agencies. These research funds have really paid off. You might want to claim that all of the increased production is due to our research efforts, but if we claim more modestly half of the total gains as contributed by our improved varieties and agronomic research, the ratio of cost to increased value to farmers shows a return of $22 for each dollar spent for research.

The payoff during the last five years for each dollar spent on research shows a return of $51 if we claim only 50 percent of the increase when compared with the 1916 to 1935 period. Certainly this may be the proper forecast for future research returns.

It is inspiring to recount some of the things that have taken place in the last two decades of sugar beet production since the inception of this Society. Twenty years ago all of the beets were produced with hand labor. The 1955 crop saw 97 percent to 98 percent of the total acreage harvested by machines, and hand topping is now a rarity. In the words of George Gobel, "You can't hardly find them things no more!"

Development of segmenting and decorticating seed brought along with it improved drills and equipment and a definite saving in labor. Application of machine thinning and weeding tools for in-the-row cultivation has drastically changed all former hand thinning methods.

Variety improvement in yield, sugar, and processing quality has had a pronounced effect on grower's production and factory operation. Only seven years ago a few monogerm seed-bearing plants were discovered in Oregon. These are being transferred into the germ plasm of present commercial varieties, and it is safe to say that in another decade, we will be considering only single germ seed strains. When we combine new hybrid monogerm varieties with selective weed chemicals and complete machine thinning, you can readily appreciate that we are on the threshold of far higher plateaus of production.

Modern machinery, equipment, and the know-how to use it has done much to save labor, and revolutionary progress has been made. We know, however, that farmers are still searching for additional ways to save time and effort.

Not all of the dramatic progress has been made in mechanization and variety improvement. Fungicides, insecticides, nematacides, weedicides, and the improvements in our processing of the sugar beet have contributed

greatly to more efficiency in production and extraction. Included in chemical advances are improved and greater use of mineral fertilizers. Our soils have been yielding larger and larger crops with better control of insects, viruses, and diseases through use of some of the newer chemicals. A new plateau of production has been realized on the sugar beet farm through a combination of these splendid achievements of our research endeavors.

We Americans get impatient for results in our way of life, and too often we probably are too practical in what we ask of agricultural research. I feel that recently there has been an improved attitude in our beet sugar research thinking toward fundamental and basic research. A few years ago studies started on the question of "how sugar beets grow." It started giving us information that undoubtedly will have a pronounced effect on our ability to increase development of the crop in the future under differences in climate and environment.

Henry Wallace recently said that basic research "has an uncanny way of becoming practical." I hope that this trend becomes apparent as achievements in future research are brought about. Quite often we get discouraged in not seeing the translation of the results of the fundamental type of research to practical application. We should not apologize for this lag between new discoveries and their general use as it is just an example of our way of doing things and in accepting new ideas. Some researchers recently reported a study at Iowa State College in the last fifteen years that there is quite a variation in the way farm folks adopt new methods. They have found that there is always a group that adopt things quickly, but there are others who are satisfied with their mode of doing things and are slower to partake of the fruits of the new ideas. On the average it takes about seven years between the time that the first people accept the new practices and general adoption by most farmers. As an example, acceptance of hybrid seed corn took fourteen years before 93 percent of the acreage was planted to the new types in the corn belt.

The studies show, however, that with chemical control of insects, weeds, and diseases, it has been found that from the time the first experimental work has been proven successful, farmers are apt to rush into using the chemicals very quickly and on a large proportion of acreage before all of the dangers have been thoroughly explored.

The acceptance of scientific advances, however, in the last few years by sugar beet growers indicates the soundness of our research and that, on the whole, we have established a very good respect for our findings and that our extension team has helped immensely. This is due to the closeness in which we operate in the sugar beet industry between the men who are responsible for disseminating the information to the growers and the actual research staffs in our Department of Agriculture, college experiment stations, and company research stations. Due to this close-knit organization, the information has been used intelligently and effectively to bring about quick use of the findings. Let us hope that this continuation of mutual respect, confidence, and understanding will sustain our work in the future.

There is one thing evident in our future research policy that should be emphasized, and that is that our soils in recent years have yielded pheno-

menally large tonnages. A withdrawal of the plant food required for these higher-yielding crops means a more rapid depletion of our resources for the future. We must be ever alert to restore and rebuild the potential soil reservoir. Fundamental knowledge of the basic processes of the sugar beet plant is necessary in order to fulfill further advances in sugar production. With every improvement in productivity of our beet strains, we must apply continued vigorous, basic studies of soil flora and physiology of the beet plant that will pay off in better nutrition for future crops. In our quest for higher sugar production, we must not overlook the use of new herbicides; new treatments for diseases, insects and pests; breeding of nematode resistance and virus resistant strains in conjunction with improved fertilizers; and in those areas where irrigation is practiced, a better, more efficient utilization of water. Let us always keep sufficient funds in our "Scientific Bank" to keep ahead of the necessary withdrawals for improved crop production.

Temperature Studies on Lime Burning

GUY RORABAUGH, L. P. ORLEANS, AND L. W. NORMAN[1]

Examination of recent literature shows very little information on the optimum time and temperature needed for burning limestone to a good lime for Steffens use. Hartman and McGinnis (1)[2] have given theory, conditions, and procedures necessary for good lime burning. Clark (2-3) has covered the mechanics of good kiln operation. Daniels and Cotton (4) have described a process for re-burning lime cake. A considerable amount has been written about the fundamentals of lime burning for commercial use (5), and Azbe (6) has examined the effect of time, temperature, and the rate of burning of limestones for the production of commercial lime. Work has been carried on at Massachusetts Institute of Technology under the sponsorship of the National Lime Association, and Murray, et al. (7-8) have examined the effect of temperature and time on lime burned from a number of limerocks.

Limes of similar chemical composition very frequently act differently in a given chemical use, and this difference in behavior is quite pronounced in Steffens operation. The nature of the limestone, the conditions of temperature, and time under which it was burned to a lime seem to be the factors that cause these differences in behavior. Physical properties rather than chemical composition seem to be the governing factor and very little is known about the differences that do occur.

As part of a program on Steffens operation we undertook burning studies on limerocks that are used in all of our Steffens operations. A large number of different rocks were studied but the results of only two will be reported here. Rock A is a limestone giving excellent lime for Steffens operation. It is a gray limestone consisting of lightly-packed, well-cemented oölites with crystals of recrystallized calcite. In it can be observed a few fossil fragments. Rock B is a dark, gray, crystallized limestone showing a wide range of crystal sizes. The calcite crystals are larger than those in A and very few fossil fragments are present. It is a difficult rock to burn, giving poor to fair Steffens lime.

Both rocks are high in calcium carbonate: Rock A, 96.75 percent and Rock B, 98.53 percent. Rock A has 1.3 percent silica and insoluble, while Rock B is 0.5 percent. The amount of iron and aluminum oxide is about 0.3 percent in each rock, while Rock A contains 1.63 percent magnesium carbonate as to a 0.9 percent for Rock B.

Preliminary tests on burning with a small coke-fired kiln proved unsatisfactory due to difficulty in controlling the many variables and inability to reproduce results. Small laboratory furnaces have been found unsatisfactory except for burning very small amounts of lime, so it was necessary to construct our own furnace. With a basic design furnished us by The Carborundum Company, a large electric-type muffle furnace was built (Figure 1). Using large Globar heating elements, special refractories and

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[1] Research Laboratory Manager and Research Engineers, respectively. Holly Sugar Corporation, Colorado Springs, Colorado.

[2] Numbers in parentheses refer to literature cited.

insulation, we are able to maintain very good control of temperature and obtain a very rapid recovery of furnace temperature due to temperature drops when samples are being placed in or taken out of the furnace. A

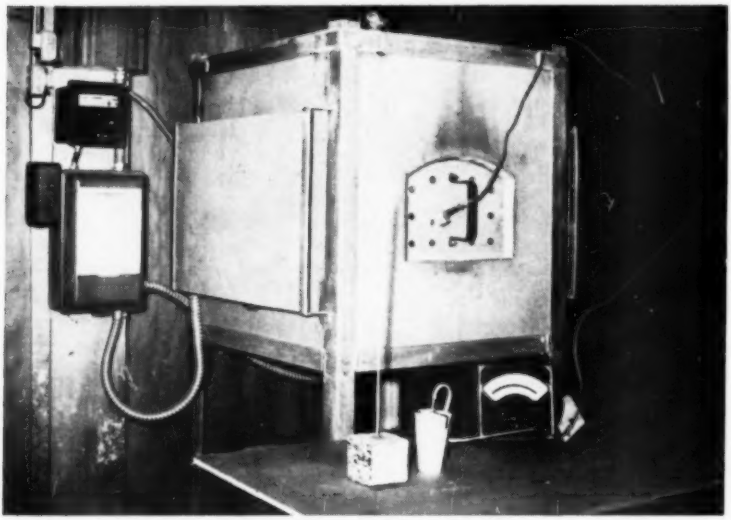

Figure 1.—Furnace for burning tests.

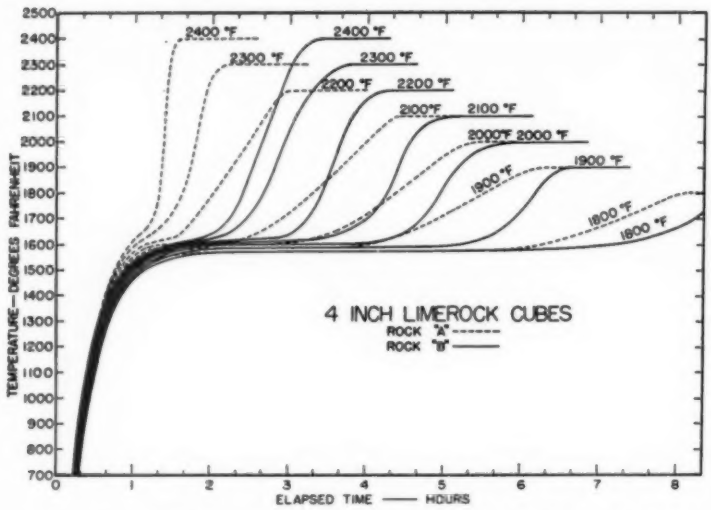

Figure 2.—Difference in burning rate 4" cubes Rocks A and B.

Wheelco temperature controller is used with a platinum, platinum-rhodium thermocouple which gives good control within 20° of any pre-set temperature.

The first studies were made on rate of burning. Large pieces of limestone were cut into cubes of 2 inches, 3 inches, and 4 inches. A small hole was drilled into each cube to the center and a thermocouple was sealed into the center of the cube. Figure 1 shows a cube with a thermocouple inserted. Before the cubes were put into the muffle furnace it was preheated to about 100° F. above the temperature being studied. By the time the samples were set in place and the thermocouples connected we found that the furnace would drop to just about the desired temperature. From there on the temperature controller held the furnace at any pre-set temperature. Temperature readings were made on the rock at ten minute intervals and the resulting temperature then plotted against time.

From Figure 2 you can see that the temperature rises very rapidly to about 1600° F., which is the approximate dissociation temperature of calcium carbonate at about one atmosphere pressure (5). The temperature remains constant until almost all of the CO_2 is calcined off, at which point the temperature again rises very rapidly to the surrounding furnace temperature. From CO_2 analysis of the lime burned on a number of cubes we found that almost all of the CO_2 was driven off at about half way up on the second steep part of the curve.

Rock B requires considerably longer time to burn out than Rock A, the difference in time varying with the temperature.

Figure 3 shows the difference in rate of burning of 2-inch, 3-inch, and 4-inch cubes and of a large slab 12 inches by 6 inches by 4 inches at 2200° F. temperature. The data on this curve shows very clearly the importance

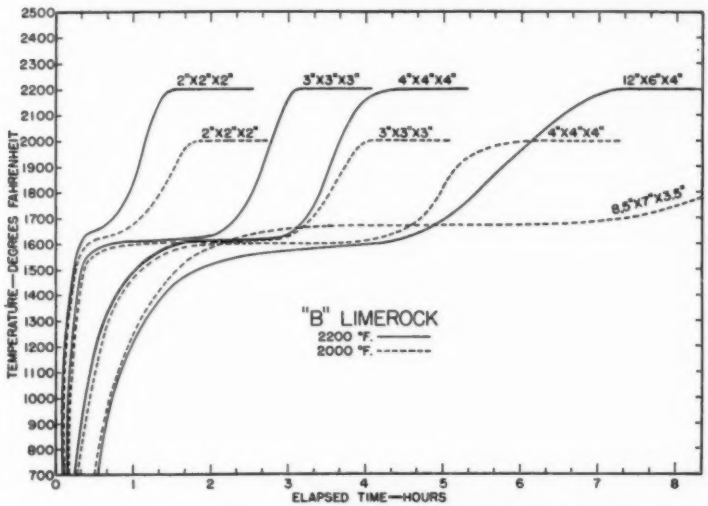

Figure 3.—Difference in burning rate for various size rock.

of even sizing of limestone to a kiln and that the thickness in dimension is not the determining factor of the rate of burning as the 12-inch by 6-inch by 4-inch slab required a much longer time to burn out than the 4-inch cube. The 8½-inch by 7-inch by 3½-inch slab required over 9 hours at 2000° F. to burn out as compared to a time of 5 hours for a 4-inch cube at the same temperature.

The data shown in Figure 2 give the time and rate of burning of the two limerocks but does not give any indication of the quality of the resulting lime for Steffens use. Previous work we had done on fineness of grind and surface area, and work done by Shafor (9), had shown that fineness of grind of the lime was a very critical factor in Steffens operation. We found it impossible to grind the lime obtained from the rate of burning tests to any comparable fineness or surface area. The lime obtained from the cubes burned at 1800° F. was soft and tended to mush up on grinding surfaces, while that burned at 2400° F. was very hard. After many attempts at trying to obtain the same fineness of grind with different equipment we gave up trying to grind the burned lime and, instead, ground a large sample of the limestone being investigated to as fine a grind as possible. From this one sample we burned portions of it in large refractory-melting crucibles at the various temperatures in order to evaluate the lime for sugar recovery. Extreme care was taken in getting samples of Rocks A and B and resulting lime to the same degree of fineness.

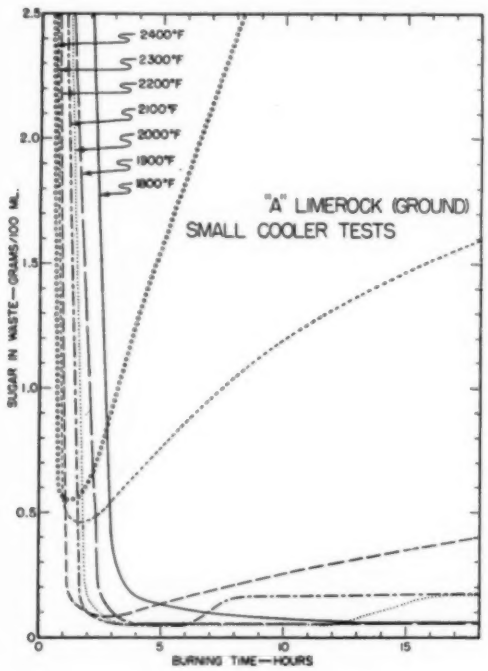

Figure 4. — Sugar recovery for lime from Rock A at different temperatures.

A standard cooler test was worked out which gave very reproducible results and in comparison with factory operation, using the same lime used in factory coolers, we obtained parallel results, getting slightly better sugar recovery with lower lime additions than that obtained in factory coolers. Lime addition was standardized at 90 lime addition per 100 sugar in molasses. Standard molasses was used at 6.1 percent sugar. The length of lime addition, temperature, and time were all held constant, with the only variable being the lime under test.

Figure 4 shows the results obtained on Rock A and Figure 5 shows the results obtained on Rock B.

Burning time in hours is plotted against grams sugar per 100 ml. in cold waste at various temperatures.

Rock A curves in Figure 4 show that at 1800°, 1900°, and 2000° F. sugar recovery is optimum and no overburning takes place up to 24 hours at these temperatures. At 2100° F. a very slight overburning is observed with increasing time which becomes more pronounced at 2200° F. However, fair Steffens lime is still obtained at 18 hours at this temperature. At 2300° and 2400° F. overburning is very rapid and the resulting lime gives very poor sugar recovery.

Rock B (Figure 5), burned under identical conditions as Rock A,

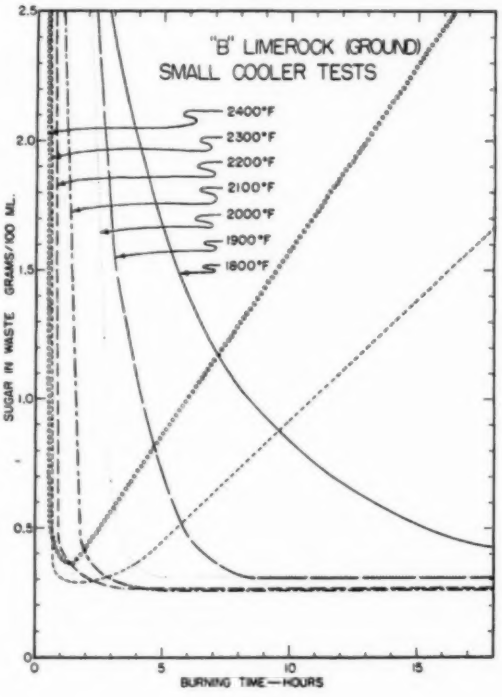

Figure 5. — Sugar recovery for lime from Rock B at different temperatures.

shows that this rock requires burning for 24 hours to reach maximum sugar recovery at 1800° F. obtained in 6 to 8 hours with Rock A. At 1900° and 2000° F., again, a longer time is required for Rock B than Rock A. No overburning was found after 24 hours with Rock B at 2100° or 2200° F., but again, at 2300° and 2400° F. overburning takes place but not as rapidly as with Rock A. A second sample of Rock B, obtained from a different part of the quarry, gave almost identical results as shown in Figure 5. Rock from one of our other plants had a rate of burning as slow as Rock B and yet showed very good Steffens results at 1800° F. in a shorter time than Rock A.

By inserting a thermocouple in the center of the fine ground limestone in the melting crucibles at a furnace temperature of 1800° F., 1 hour 10 minutes was required for both Rocks A and B to reach approximately 1600° F. At 4 hours 10 minutes the temperature in Rock A rose rapidly to the furnace temperature but it required 5 hours 10 minutes to reach the furnace temperature with Rock B.

From Figure 4 Rock A reached maximum sugar recovery in about the same time, 4 hours 10 minutes, that it reached the furnace temperature; but with Rock B (Figure 5) 24 hours at 1800° F. was required to reach maximum sugar recovery. Yet, it required only 5 hours 10 minutes to reach furnace temperature.

Figures 6 and 7 on Rocks A and B were obtained by combining the data of the rate of burning tests on various sizes of cubes, and the data obtained on the powdered limestone for sugar recovery correcting for the time required for the powdered lime to rise to furnace temperature. Within

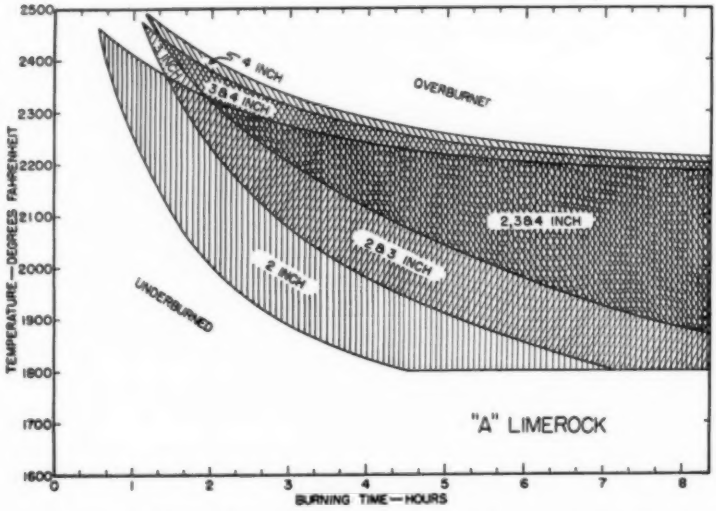

Figure 6.—Curves showing optimum time and temperature for good Steffens lime for Rock A.

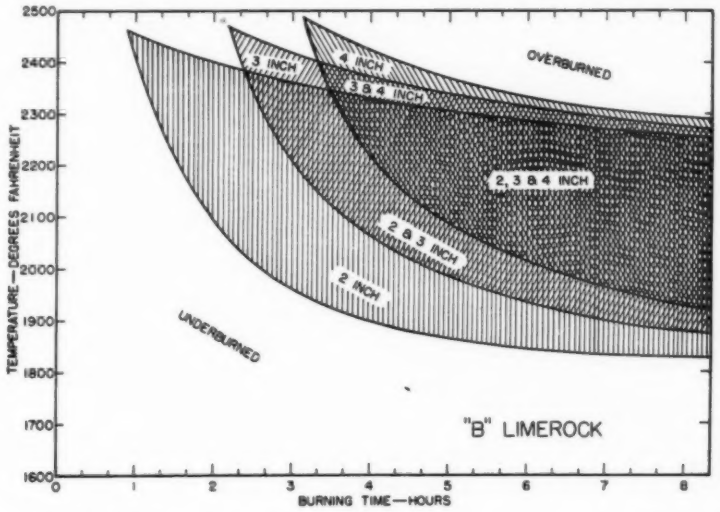

Figure 7.—Curves showing optimum time and temperature for good Steffens lime for Rock B.

the shaded area for each size rock represents the time and temperature at which the rock can be burned to an optimum Steffens lime, and outside of these areas is either overburning or underburning.

One of the quarries which is a source of limestone for one of our plants has two definite types of limestone, one very soft and the other extremely hard. Samples of these two types were ground to the same degree of fineness and burned at several temperatures. Very little difference in the small cooler test curves was obtained; or was there any difference in the rate of burning of cubes cut from the two different type rocks.

We have found considerable variation between the temperature of overburning existing between different limestones. One limestone considered good for Steffens lime showed almost the same degree of overburning at 2000° F. as shown in Rock B at 2300° F., and at 2200° F. for this rock the resulting lime was worthless for Steffens recovery in a very short time.

The conditions of temperature and time under which we conducted our studies do not approach those that exist in a vertical lime kiln using coke as a fuel. However, the results we obtained have shown the importance of burning temperature and time on lime for Steffens use and the large variation that exists between limestones. Even with the difficult to burn limestone, such as B, good Steffens lime can be obtained if the optimum conditions of temperature and time are met.

Control of temperature in a vertical coke-fired kiln is very difficult and extreme variations of temperature exist that vary from day to day

or even from hour to hour. Accurate measurement of the temperature through a vertical kiln is very difficult to obtain, and probably once obtained, is not too accurate.

Figure 8 shows the data from a series of 12 different determinations made over a period of several days on one of our lime kilns in regular operation. To obtain the difference between the outside porthole-temperature measurements and the actual temperature at the center of the kiln a number of comparison measurements were made by driving a 1¼ inch tubing into the center of the kiln and then sighting through the tube with an optical pyrometer and measuring the temperature at the end of the tube. Over a number of measurements taken with considerable difficulty the average difference was 140° F. from the center to the outside wall of the kiln. Shown in Figure 8 is the kiln divided into zones and the approximate time the rock is in each zone based on a 24-hour cycle obtained by the average time a number of firebricks took to pass through the kiln when charged with the limerock while in regular operation. The temperatures

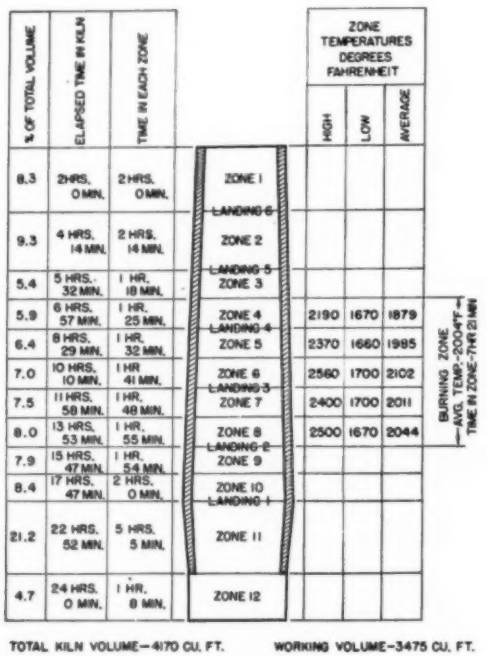

Figure 8.—Retention time and temperatures measured in vertical kiln.

in each zone are average temperatures obtained from a number of temperature determinations and corrected for the center to outside cross-sectional measurements. The high and low temperatures obtained are shown which were measured in each zone from day to day and from porthole to port-

hole in the same zone. The temperature differences in this kiln may not be typical of all vertical kilns but do show that large variations of temperature do exist in a kiln.

Zones 3 and 9 at times would show temperatures above 1600° F., but for the most part both were below this temperature and can be considered pre-heating and cooling zones. Considering that the calcining zone exists between 3 and 9 and calculating the time the rock is in this zone on a percentage volume basis, the time the rock is in this zone is approximately 7 hours 20 minutes with an average temperature of 2000° F.

From Figures 2 and 3 a 4-inch cube would burn completely out, but larger pieces, such as 8½ inches by 7 inches by 3½ inches would only be partially burned. Small pieces, such as 2-inch cubes, would burn out by the time 5 and 6 zones are reached and be badly overburned when subjected to the high temperatures in the hot spots of 2500° F. that sometimes exist in the zones below. We can see that the lime obtained from vertical kilns such as this is a mixture of overburned and underburned lime and probably very little of the lime has been subjected to the optimum conditions for good Steffens lime.

In general, longer cycles with lower burning temperatures using very even sized rock should give better lime for Steffens use, using vertical coke-fired kilns.

The temperatures that exist in the hearths Nos. 6 to 10 of a Skinner roaster should be ideal for burning limestone to good Steffens lime. and it has been shown that lime from such a roaster is excellent for Steffens use (4). The fluidized solids calciner developed in recent years with close temperature control should also give excellent lime for Steffens use. and it is not inconceivable that with proper mechanical technique a method of rapid flash calcination using finely pulverized material could be developed that would be the ultimate for producing lime for Steffens use.

Calcination at higher temperatures of lime for long periods of time is believed to result in the inter-atomic spacing in the crystal lattice becoming so small that water molecules can penetrate only slightly (6). We have shown in the limerocks which we have examined under the conditions reported here, that up to 2000° F. for 24 hours had little effect on the quality of lime for Steffens use. At 2000° F. some rocks undergo a slight modification after prolonged heating at this temperature (Figure 4), while others may overburn more rapidly. Rock B (Figure 5) did not show any change at 2100° F. up to 24 hours. Some rocks give good Steffens lime at 1800° F. in a short time, such as Rock A, while others, such as Rock B, require prolonged time even after the CO_2 is driven off to show maximum sugar recovery.

From our work we believe that thermal analysis of limestone is valuable in determining the suitability of limestone for Steffens use and, also, in determining the burning range for individual limestones. Of the many limestones we have examined, each has shown an individual characteristic curve which seems to be typical of the quarry from which it is obtained, regardless of place in the quarry or type of rock.

Chemical constituents, except very high levels of accepted fluxing agents, do not seem to have any effect on the resulting lime for Steffens

use. A number of reagent grade chemicals were added to pure reagent grade calcium carbonate. Both the calcium carbonate and chemicals were finely powdered and mixed well. Each sample prepared contained 1 percent of the added chemical and 99 percent calcium carbonate. All samples were burned at 2200° F. for eight hours under identical conditions and a check sample of the pure calicum carbonate was included for comparison. Small cooler tests on the resulting lime, using 80 lime addition, were made and the sugar recovery was identical for all samples with the check.

The following chemicals were used: aluminum silicate and acetate, sulfur, sodium carbonate, ferrous carbonate, sodium silicate, magnesium carbonate, and silica. Wide differences were observed in the physical appearance of the resulting limes. Both sodium samples were very dense, while others, such as magnesium carbonate, gave resulting powders that were very light and fluffy.

X-ray diffraction studies made so far have proven disappointing and inconclusive on both the original limestones and resulting lime burned from them. Burning tests and small cooler evaluation of the lime obtained from two different reagent-grade, high-purity calcium carbonates have shown wide differences to exist between the two in the temperature required to bring them to a good Steffens lime. This work is not completed and an X-ray diffraction study is indicated on these reagent-grade calcium carbonates and the lime obtained from them. Perhaps from such study, using these pure materials, a better interpretation of the results of X-ray diffraction on limestone and lime can be made.

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Interspecific Hybrids in the Genus Beta

R. K. Oldemeyer and H. E. Brewbaker[1]

Vulgares x Patellares Hybrids

The species in the section *Patellares* Transch. of the genus *Beta* L. have many characters—nematode immunity, leaf-spot (*Cercospora*) and curly top resistance, and monogerm seed—which if transferred to sugar beets, would be of great economic importance. Initially the block preventing the transfer of these characters was the inviability of the F_1 hybrids, with one exception; Stewart grew an F_1 hybrid which produced additional generations but eventually all succumbed (3)[2]. Sterility of the F_1 hybrids blocked transfer after hybrids were grown to maturity following grafting (1) and the use of bridge hybrids (2) (4).

A search for a race or species in the section *Vulgares* Transch., which would allow the production of many viable F_1 hybrids with *Patellares* species, was begun by the Great Western Sugar Company in 1951. Viable but sterile bridge hybrids were obtained in some crosses (4).

Crosses involving the Detroit Dark-Red variety of table beet with *Beta procumbens* Chr. Sm. and *B. Webbiana* Moq. were made in 1953. Most of the F_1 hybrids were viable with a growth habit similar to the hybrids with Swiss chard reported by Gaskill (2). The heavy anthocyanin pigmentation from the table beet carried over to the hybrids, however. Fifteen hybrid plants flowered profusely, but on exposure to sugar beet pollen, only one seed was set. No sound pollen was found when squashed anthers were stained with acetocarmine. The one seed has produced a weak plant which will probably die before it flowers (Photo 1).

Another cross involving an annual wild beet, *Beta maritima* L. with *B. procumbens* and *B. Webbiana* resulted in viable hybrids. Two hybrid plants (*B. maritima* x *B. procumbens*), morphologically identical and quite similar in growth habit to the *B. macrocarpa* x *B. Webbiana* hybrid reported by Oldemeyer (4) in 1954, flowered in 1955. One was completely sterile; about 4 percent of the flowers of the other produced seeds. Four other F_1 plants from the same crosses will flower in 1956.

About 1,000 seeds were harvested from the semi-fertile hybrid following pollination with sugar beet pollen. When the embryo cavity was exposed after the pericarp had been trimmed with a razor blade in scarification, many seeds contained only empty brown embryo sacs indicative of embryo abortion. Many seeds contained fully developed embryos, and about 400 seeds were saved. A progeny of 56 backcross plants is being grown. For the seeds saved, a yield of about 45 plants per 100 seeds was obtained. Many additional progeny will be obtained in the future; the original plant is thriving, and it is also being vegetatively propagated by clones.

The oldest backcross progeny are thriving, and the leaf rosettes resemble sugar beets closely (Photo 1). The petiole veins are deeply pigmented

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[2] Numbers in parentheses refer to references.

Figure 1.—Three thrifty progenies, background, of a *Beta maritima* x *B. procumbens* hybrid resulting from pollination with sugar beets. A weak progency, foreground, of a red table beet x *B. procumbens* hybrid, resulting from pollination with sugar beets.

which could have been transmitted from either parent of the original hybrid. Under cold temperature, 50° to 55° F., and short day length, the plants show no signs of bolting.

The success of this particular cross was probably dependent on the *B. maritima* source, PEI 206411, an introduction from Turkey. Other *B. maritima* crosses have proven unsuccessful, and there have been no observed differences in crosses where various races of the *Patellares* species have been used (4).

It is hoped that sufficient interspecific chromosomal pairing and crossing-over will take place in the hybrid plant, and that some of the backcross progeny will carry germ plasm for the desirable traits present in the *Patellares* parent. If some of the desirable germ plasm is passed on to the progeny it may be possible to recover it in plants cross compatible with sugar beets. It would then be only a matter of backcrossing to incorporate the traits into sugar beet varieties.

This hybrid is most encouraging. No polyploid barrier exists, as would be the case if fertility were restored by chromosome doubling. With the possibility of producing a multitude of backcross progeny, the chance of recovering nematode resistance, disease resistance, and monogermness, in a useable form may be within reach.

Vulgares x Corollinae Hybrids

The species *Beta lomatogona* F. et M., *B. intermedia*. Bunge, *B. macrorhiza* Stew. and *B. trigyna* W. et K. in the section *Corollinae* Transh. probably do not contain as spectacular germ plasm as the species in the section *Patellares*. However, they are extremely interesting for the cold-resistance germ plasm they contain. All are long-lived perennials, and at Longmont, Colorado, many are 14 years old and still alive. It may also be possible that these species carry cytoplasm for male-sterility in sugar beets which is not presently available.

Five *B. vulgaris* (sugar beet) x *B. intermedia* hybrid plants were obtained in 1939. These plants grown in 1940 were transplanted to a permanent garden location in 1941 where one F_1 root survived 12 winters without protection (Photo 2).

Figure 2.—A sugar beet x *Beta intermedia* hybrid with exposed roots after growing for 12 years.

Morphologically the hybrid plant was nearer its *B. intermedia* parent than sugar beet, although such characters as leaf smoothness and flower bracts showed the *B. vulgaris* parentage. The plant was highly sterile, but a total of nine offspring have been obtained following pollination by *Corollinae* plants of the species *B. lomatogona*, *B. intermedia*, and *B. trigyna*, and by sugar beet plants. Three of the offspring resembled sugar beets, had none of the *Corollinae* characteristics, and were fully fertile. Three were highly sterile and similar in growth habit to the F_1 hybrid, and three had all the characteristics of the *Corollinae* parent and were fully fertile. The viable gametes evidently contained either a full set of *Vulgares* or

Corollinae chromosomes to produce such progeny, indicating the chromosomes of the two species are non-homologous. It may be quite difficult, if not impossible, to transfer *Corollinae* germ plasm to sugar beets.

To determine the extent to which the *Corollinae* will hybridize with sugar beets, a group of cytoplasmic male-sterile sugar beets were planted in the perennial nursery in 1952, at Longmont, Colorado, which contained plants of *B. lomatogona, B. intermedia,* and *B. trigyna.* The chromosome number of some of the sugar beet plants had been doubled by colchicine. A great number of hybrid seedlings were produced which were easily identifiable by their slow growth and intermediate growth habit. All were highly sterile and only a few seeds were produced. Characteristic growth types were present, clearly indicating the three *Corollinae* species had participated in pollination.

Two changes in technique would be desirable in future hybridization. The use of "Mendelian" male-sterile sugar beet parents to produce large numbers of hybrids rather than cytoplasmic male-steriles would eliminate male-sterility problems in later generations. If the *Corollinae* species were used as the female parent, cytoplasm which would cause male-sterility in sugar beets could express itself in advanced generations, if present.

Summary

Hybrids of Detroit Dark-Red table beet with *B. procumbens* and *B. Webbiana* are quite viable but highly sterile. Two hybrids of *B. maritima* x *B. procumbens* flowered. One was highly sterile, the other produced a number of seeds when exposed to sugar beet pollen. Others of the same type of hybrids, one involving *B. Webbiana,* will flower in 1956. The offspring resulting from pollination of the semi-fertile hybrid with sugar beets are quite thrifty, and there is hope that the desirable traits of the *Patellares* species can be transferred to sugar beet. The success of the cross is attributed to the *B. maritima* parent (PEI 206411).

A long-lived hybrid between sugar beets and *B. intermedia* is reported. Its progeny indicates there is little homology between the chromosomes of the two species. Hybrids of sugar beets with *B. lomatogona, B. intermedia,* and *B. trigyna* are also reported.

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Experiences with Automatic Tare Samplers

P. M. Rosenow[1]

Down through the years the problem of taking accurate samples for determining tare on beets has been a constant source of concern, both on the part of the grower and the processor. With the advent of central tare-houses whereby the samples are washed and crowned mechanically under constant supervision by Growers Association and company personnel, there is little concern left as to how accurately the job is done. This leaves only the sampling operation where there can be any doubt as to accuracy.

It has been pretty well established that by taking a certain number of samples per day from loads delivered and by taking the sample from the same part of each load, the resulting average tare of such samples for the day will check, within tolerable limits of accuracy, with the actual tare of loads delivered. Where then, can any doubt exist? We believe that the doubtful point is the "human factor"—the man who actually takes the sample. Accuracy can be attained by human hands but it depends entirely upon the integrity of the individual who is doing the sampling. Assuming the sampler is honest and will endeavor to catch each sample to the best of his ability, we still have a condition, at least in the Hardin factory area, whereby it is almost physically impossible for a human to catch an accurate sample.

In a major portion of the Hardin area, the soil is a heavy gumbo type that will adhere to the beet when moist, and will form unbreakable clods when dry. In either of these conditions, it seems that it is impossible to force the hand sampler back through the stream of beets and clods to a point underneath the apron below the screen. It is doubtful if this is ever accomplished even in good clean beets because of the awkward position of the man, and the little purchase he has on the operating handle to force the sampler completely through the stream of beets.

It was for this reason that in 1946, L. R. Cool, who was then chief agriculturist at Hardin, began thinking of something mechanical that would eliminate the human element. He directed the construction of the first mechanical taresampler and like the first model of any machine there were a lot of bugs to eliminate. The important thing was that obviously it would be a success. The mechanical sampler has the power to force the bucket completely through the stream and is designed in such a manner that the bucket must complete the forward cycle before it will reverse and retract from the stream. Incidentally, the bucket cannot hesitate in the stream of beets for over a fraction of a second, which was one complaint always made against a hand-operated taretaker.

After many trials with various concerns, Silver Engineering Company became interested and built the first models in 1954. Two of these models were purchased for the Hardin area and were installed on the two stations that we considered the toughest from the standpoint of delivery and con-

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dition of beets and mud or clods. These earlier models were simply the mechanized version of the hand model and required a man up in the tare-house to lift out the sample bucket and empty the sample into the bag. These two models were very successful from the mechanical point of view and were enthusiastically accepted by the growers. With this successful step accomplished, we insisted on going ahead, as was originally envisioned, and add a self-dumping feature which would deliver the sample down to the ground level through a chute where it would be caught in a bag.

We asked Silver Engineering for such a model, and in 1955 they produced four machines which we installed on pilers in the Hardin area. We had a few mechanical difficulties to begin with; the major one being that beets would sometimes get between the sample bucket and the tub on the boom of the piler which would stop the travel of the sampler. All of the problems were worked out and we now believe the machine is as mechanically sound as any piece of machinery.

The control for the taresampler is located on the back of the piler where the piler operator stands. The operator was chosen as the one to determine the time at which the sample is to be taken because he is the only one who can observe how much of the load has been delivered and also can be sure that the screen is running full when the sample is taken. The sample man, who is on the ground, collects the tare ticket from the truck driver and then steps over to the sampler chute, places the ticket in the tare bag and then places the opening of the bag around the chute and waits for the sample to fall. After the sample has been bagged, he places the sample on a pile to the side of the piler and has time to help prepare for the next truck. The whole operation has taken place in full view of the grower or person who delivers the beets, which we find to be a very favorable psychological effect.

We like the idea of having the sample man on the ground not only for the above mentioned reason, but there are always some stations where delivery is not sufficient to warrant three men; but is necessary because the tareman is up in the tarehouse where he cannot assist in any of the work connected with the dumping of trucks. In most cases one man can be eliminated, even on larger stations after the peak of deliveries has passed.

Numerous tests on the size of the sample indicated an average of 21 to 27 pounds per sample depending upon the area from which the beets were delivered. Very rarely does the sampler catch too small a sample and when it does it is a simple matter for him to signal the operator for another sample.

We have all our pilers electrified with 440-volt current and use 440-volt equipment in connection with the tare taker; but I presume 110-volt equipment could be used, which would allow their use on more pilers which are not equipped for an electric motor on the piler.

As indicated previously, the growers have enthusiastically approved the machine and we think enough of these taresamplers that we intend to have one on each piler in the Hardin area.

Effect of Chemical Treatment on Respiration of Sugar Beets

R. T. NELSON[1]

The reduction of losses of sugar in sugar beets between lifting and processing has been attacked by various means. Of first importance is the prompt efficient handling of the beets from the time of lifting until they are in the factory or in the storage pile. Of second importance is the reduction in temperature within the storage piles by use of forced-air ventilation. Reduction in storage losses has also been sought by means of chemical treatment. The studies made with maleic hydrazide are probably the most widely known.

This paper covers results obtained with 3-amino 1, 2, 4-triazole[2] as an anti-respirant for[3] sugar beets. In preliminary trials involving seven materials the amino triazole appeared to be the most promising in reducing the respiration rate. The other six materials were identified only by code number and after one preliminary trial all six materials were dropped from current investigations. Thus, the results given here are confinded to amino triazole.

What effect amino triazole would have on respiration rate was investigated first by dipping momentarily transverse sections of sugar beet roots into aqueous solutions varying in concentration. After dipping, the excess solution was allowed to drain off. The evaluation of respiration rate was then identical with a procedure previously published (1)[3]. Samples from ten roots were analyzed for each concentration. A treated and untreated sample from each beet was evaluated simultaneously. (See Table 1.)

Table 1.—Decrease in Respiration Rate Obtained on Root Sections[1]. Dipped in Solutions Varying in Concentration of Amino Triazole.

Concentration (ppm)	10	50	250	500	1000	2000
Percentage decrease from check	0.8	4.2	12.0	19.6	24.7	13.4
LSD 5% pt.	NS[2]	1.9	7.0	4.2	7.1	5.6
LSD 1% pt.	NS[2]	2.8	10.1	6.0	10.3	8.0

[1] Carbon dioxide production was measured over an 18-hour period immediately after slicing and dipping.

[2] Difference between check and treated not significant at indicated level.

The results of Table 1 indicate a very definite decrease in respiration rate for all treatments except the 10 ppm treatment. Only a limited amount of solution adhered to the freshly cut sections, approximately three percent by weight. Assuming a three percent gain in weight of sections on dipping, and equal distribution, the concentration of amino triazole within the treated beet tissues would have been 0.3, 1.5, 7.5, 15, 30 and 60 parts per million, respectively.

After obtaining results in Table 1, a trial was made dipping three samples of whole beets. A solution of 8000 ppm amino triazole was used. After solution had ceased to drip off the beets, it was estimated amino triazole on weight of beets would be less than 40 parts per million. Three

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[2] Commercial firms furnishing amino triazole were American Chemical Paint Company and American Cyanamid Company.

[3] Numbers in parentheses refer to literature cited.

comparable samples were left untreated. Each sample was then placed in a water-proofed bag and stored for two weeks in the root cellar at approximately 40° F. before being sliced and analyzed. Results appear in Table 2.

Table 2.—Respiration Rates at 70° on Sliced Sections of Roots Two Weeks After Roots Had Been Dipped in 8000 ppm Aqueous Solution of Amino Triazole. Values are mg. CO_2/kg./hr.

Treatment	Replicate			Mean	Reduction in Respiration
	1	2	3		
Control	127	144	140	137.0	—
Dipped	111	131	128	123.3	10%
LSD 5% pt.				5.2	
LSD 1% pt.				12.0	

Surface treatment of roots gave a significant reduction in respiration rate as indicated by results in Table 2 based on carbon dioxide production measured on transverse beet root sections approximately 1/12 inch in thickness and 1 1/2 inch in diameter.

To further evaluate the effect of amino triazole on respiration rate of beets a second method of measurement was used. In this case 100-pound samples of beets were placed in sealed drums and oxygen consumption measured according to method previously described (2). Beets were dipped just before placing in drums. Treatments and results are given in Table 3.

Table 3.—Oxygen Used by Beets of Each Treatment as an Average of Six Replications for a 17-day Period at 70° F.

Treatment	0_2 at V_0 used per 100 lb. beets/day	CO_2/kg./hr.[1]	Respiration rate in % of control
	cu. ft.	mg.	
A) Control	.4546	23.38	—
B) Roots dipped in sol. 3,000 ppm amino triazole	.6056	31.14	133
C) Roots dipped in sol. 13,000 ppm amino triazole	.7261	37.34	159
LSD 5% pt.	.0720		
LSD 1% pt.	.1024		

[1] A respiration quotient of one was assumed in calculating CO_2 from 0_2 measurements.

The results of oxygen measurements on whole beets (Table 3) show a definite increase in respiration rate due to treating beets by dipping in amino triazole solutions. This is in direct contrast to results obtained by measuring CO_2 production on sliced tissues and reported in Tables 1 and 2.

To check whether a difference in source of roots could have accounted for this reversal in results representative beets were taken from the sealed drums at the end of the 17-day period and measurements made of carbon dioxide production from sliced sections. Again the results obtained for tissue sections followed the trends established in Tables 1 and 2. The reduction in respiration rate for the 3,000 and 13,000 parts per million treatments compared with the control were 18 and 29 percent, respectively. A value of 17 was required for least significant difference at odds of 99 to 1.

Considering that amino triazole solutions in concentrations used for treating whole beets could have been injurious to the epidermis, foliar applications were initiated the following fall as an alternate method of treatment. Assuming amino triazole would be translocated to the roots,

applications were made at rates of 1/16 pound to 1 1/2 pound in 25 gallons water per acre as an over-all foliage spray. After several trials one learned to expect a somewhat lower respiration as measured on cut-root sections taken from beets showing chlorosis of the protected small center leaves. Chlorosis was usually first visible 5 to 10 days after spraying. The necrosis of the leaves hit directly by the spray was much sooner and much more noticeable.

Average respiration rates in percentage of control on sliced root sections, based on sixteen replications from field sprayed plots, were 94.8 and 94.9 for the one-half and one-pound rates of amino triazole. A difference of 3.7 was required for least significant difference at odds of 19 to 1. Since the reduction in rate approximated 5 percent, it is likely to be real and follows the trend established in Tables 1 and 2.

Respiration rates of whole beets and measurements for quality of beets from plots sprayed October 12 are given in Table 4. In this test there were four replications. Harvest of plots was completed November 7. Respiration rates on beets placed in sealed drums was completed on December 23 and oxygen consumed was measured daily for 44 consecutive days. The weight, sugar percentage, thin juice apparent purity, and raffinose determinations reported in Table 4 were made on December 27 and on the beets which were removed from the sealed drums December 23.

Table 4.—Results on Beet Roots Harvested from Field Plots Which Had Received Foliar Application of Amino Triazole (AT) Three Weeks Before Harvest.

Treatment	Respiration of Whole Beets	Results after 44 days storage at 70° F.			
		Weight	Sugar	Purity	Raffinose
	% of control	% of control	%	%	
Control	100	100	14.9	88.3	none
AT ½ lb/a	106	100	14.6	87.6	none
AT 1 lb/a	102	99.6	14.1	86.7	none
LSD 5% pt.	NS	NS	NS	NS	—

The results in Table 4 are not conclusive in themselves. The question remains unanswered as to whether treatment with amino triazole can be effected so as to reduce the respiration rate as measured on whole beets. However, current evidence is against gaining any practical benefits. The reduction in sugar percentage and purity parallel results of other tests if attributed to the slower development of the beet in the field after treatment and not as having occurred during storage.

Discussion

In reviewing the results, particularly Table 3 with those of Tables 1 and 2, one is faced with the problem of rationalizing the differences. Sucrose and purity evaluations on beets treated and stored have not suggested the respiration quotient was abnormal which otherwise could explain the difference. However, a simultaneous measurement of CO_2 and O_2 was not made.

It is possible the high concentration of amino triazole used for treating whole beets was injurious to the tissues first contacted. The injured tissues of the treated versus the untreated may have accounted for the relatively higher respiration in similar manner as weather-beaten roots respire at a faster rate than freshly stored beets.

In Table 3 one will note the calculated CO_2 per kilogram per hour ranges from 23 to 37; whereas, in Table 3 the range is 111 to 144. Thus, the respiration of the sliced sections was approximately five times the activity measured on whole beets. One might argue that the effect of amino triazole on respiration was secondary and only caused a reduction in respiration when the rate was several times higher than the rate common for whole beets.

Also, a possibility which appears presently quite feasible is that specific tissues react differently to amino triazole. On slicing beets one likely changes the relative role various tissues play in the total respiration. Thus, if amino triazole has a different effect on various tissues, a reversal in respiration rate as measured by the two methods could be realized. Of interest in this regard is the work of Heim, Appleman, and Pyform (3) where they observe a difference in effect on catalase activity between catalase of the blood versus that of liver or kidney tissue following injection of amino triazole into adult female rats.

Summary

Sugar beets were treated in an attempt to reduce the respiration rate. Preliminary results using amino triazole as an anti-respirant appeared highly successful. A reduction in CO_2 production was obtained when sliced root sections were used as material for measurements. The reduction in rate of CO_2 production was obtained when measured on sliced tissue, whether the sliced root sections or the whole roots were dipped directly into amino triazole solutions prior to CO_2 measurements; or if treatment of roots was by translocation of amino triazole from foliage applications made to beets growing in the field.

A definite increase in respiration rate was obtained when measurements were made on whole beets which had been treated by being dipped into solutions of amino triazole. Rate of respiration was based on measurements of oxygen consumed by samples of whole beets over a period of several days following treatment. Since the respiration rate as measured on whole beets is of prime importance, the current evidence is against any practical benefits from treatment with amino triazole. A discussion is given regarding the reversal in results between those obtained from sliced root sections and those of whole roots. There is a real need for a procedure that could be used to justly evaluate and screen the many chemicals that might serve as anti-respirants and reduce the losses from respiration in beets between lifting and processing. It is likely that two or more quick methods would need to be used in any adopted procedure.

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A Grafting Method to Increase Survival of Seedlings of Interspecific Hybrids Within the Genus, Beta

R. T. JOHNSON[1]

For several years there has been intermittent interest displayed in three species of *Beta;* namely *patellaris, procumbens,* and *webbiana,* often referred to collectively as the section, *patellares.* It has been shown on several occasions that these three species all exhibit resistance or immunity to curly top, leaf spot and to attack by the sugar beet nematode, *Heterodera schachtii.* A few investigators (1, 2, 4 and 5)[2] have reported their results with crossing plants of these species to *Beta vulgaris.* Results have varied, but as yet no one has been able to successfully combine the resistance from any of the members of this group with the other desirable qualities of the sugar beet, *Beta vulgaris.* The main reason for this is apparently the seedling lethal condition of the F_1 hybrids between *Beta vulgaris* and these other species. Stewart (5) reported the survival of a few seedlings of a cross between a sugar beet and *B. procumbens* and their propagation to seed, but was unable to maintain the progeny through later seed generations and the material was lost. Gaskill (2) has reported the survival of a few seedlings from crosses of swiss chard to *B. webbiana* and *B. procumbens.* He also reports that such F_1 plants exhibit resistance to the sugar beet nematode. Oldemeyer (4) has obtained a few viable plants from crosses between members of the species, *Beta vulgaris,* other than the sugar beet, and plants in the section, *patellares.*

In all the above methods of attempting to propagate the plants derived from these interspecific crosses, the survival of the F_1 plants was, at best, poor. Coe (1) studied a grafting technique to improve this survival. This consisted of grafting the small F_1 seedlings while still alive into the apex of very young sugar beet seedlings. The survival he obtained was about 7 percent.

The study being reported here is also of a grafting technique which has given a higher percentage of survival. F_1 hybrids were produced in the greenhouse by open pollinating male sterile sugar beet flowers with pollen from plants of *B. patellaris, B. webbiana,* and *B. procumbens.* Hybrid seed was readily produced in this manner. Some contamination occurred from sugar beet pollen from a nearby flowering sugar beet but the resulting seedlings could be readily identified from the hybrids. The hybrid seedlings emerged later, grew much more slowly after emergence, and all had red flecked cotyledons. None of the hybrids from these crosses grew to maturity. Some plants died in the cotyledon stage; some progressed to the two true-leaf stage; but none survived beyond the eight-leaf stage. Several nutrient solutions including rooting hormones failed to stimulate the development of roots on any of these seedlings.

It was at this point that the possibility of grafting for prolonging the lives of these hybrids was investigated. Many types of grafts were attempted and most of them failed to give satisfactory survival percentages of the

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[2] Numbers in parentheses refer to literature cited.

Figure 1.—A leaf and axillary bud are cut away from stem of the stalk in a vegetative area below the area of elongation, usually 3 to 4 inches below the apex.

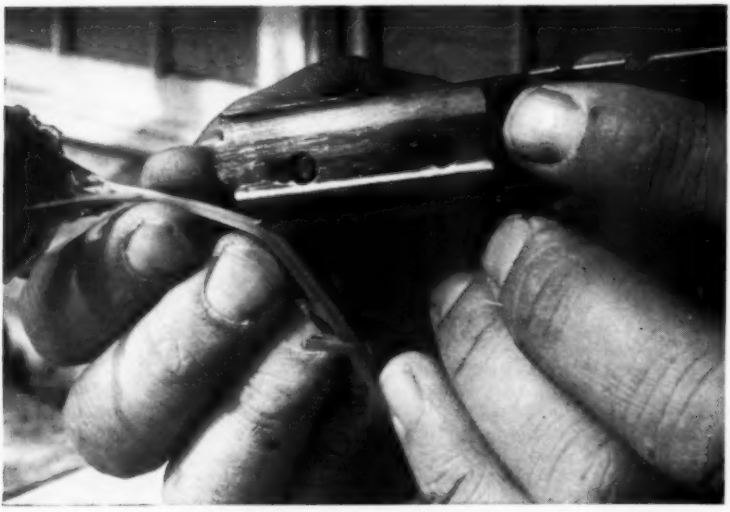

Figure 2.—A longitudinal incision is made in the stalk in the area of the excised leaf and bud.

Figure 3.—The tapered scion is inserted into the incision on the stalk. Bending the stalk helps keep the incision open and prevents damage to the scion while being fitted into incision.

seedlings. One method, however, was an exception and with this method, a survival percentage of about 70 percent of the grafts attempted was achieved. This method was as follows: The root stock consisted of a bolting sugar beet with a seed stalk from six to fifteen inches in height. One of the leaves and the axillary bud was cut away on the seed stalk in a very succulent area (Figure 1) below the area of elongation and above the hard tissue of the lower seed stalk. A longitudinal incision, from one-fourth to three-eighths of an inch long and extending about three-fourths of the way through the stem, was made in the area of the excised leaf and bud with a razor blade or other sharp instrument (Figure 2). The scion consisted of a small seedling from the cotyledon to the four-leaf stage of growth.

At about the level of the soil, either a slanting or wedge shaped cut was made through the hypocotyl of the scion, so the root was completely cut off. This scion was then placed into the incision of the seed stalk (Figure 3), care being taken to match one of the cut surfaces of the scion with the side of the incision on the root stock. This graft was then bound into place with a piece of twine (Figures 4 and 5). All other leaves and buds were removed from the seed stalk except one leaf above the graft. This one leaf is left to prevent the seed stalk from dying back below the graft before the tissues have grown together. The completed graft was then placed in a cool, shaded area in the greenhouse and left until signs of growth began to show in the scion. This usually required about two weeks. When they began to show growth, they were placed out in the sunlight in the greenhouse where they continued to develop vigorously and many of them flowered very readily. The twine should be cut soon after growth starts.

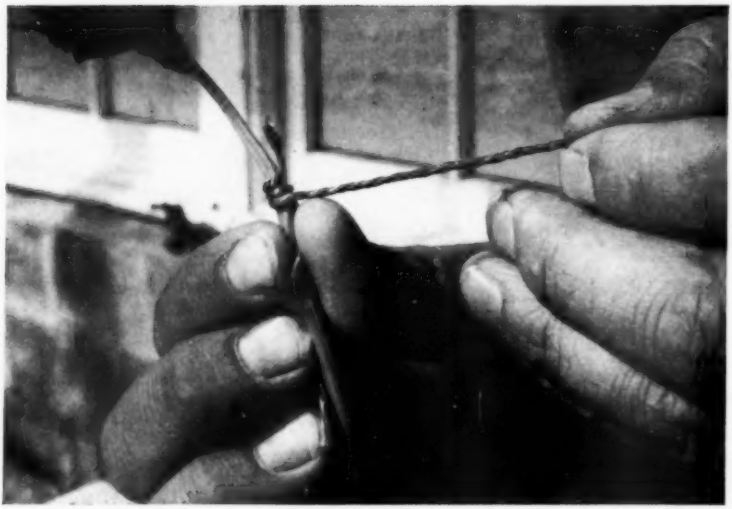

Figure 4.—Twine is wrapped firmly around graft above and below the scion to prevent the sides of the incision from healing away from the scion.

Figure 5.—The completed graft is placed in a cool, shaded section of the greenhouse until the scion begins to show signs of growth. When scion begins to grow, the twine should be cut to prevent binding. Use of rubber bands for tying grafts may be better than twine.

to keep from restricting growth. At first, there appeared to be a significant increase in survival by refrigerating the completed graft at 45° F. for twenty-four to forty-eight hours. A later comparison failed to confirm this advantage, so the refrigeration was discontinued in later grafting work.

By using this method, sugar beet seedlings and hybrids between sugar beets and members of the section, *Patellares,* were satisfactorily grafted onto sugar beet seed stalks. Similar seedlings, however, did not survive when grafted onto plants of *B. patellaris, B. procumbens,* or *B. webbiana,* nor did seedlings of these latter three species survive when attempts were made to graft them onto sugar beet seed stalks, although only small numbers of plants were involved in these last mentioned types of grafts. Axillary buds of other sugar beets were readily grafted in this manner and could be used to maintain clones of self-sterile sugar beets if so desired.

An annual beet was the source of the seed stalk most often used. This was because of the ease with which a seed stalk of the desired size could be obtained. Biennial beets were used with equal success when available.

The F_1 hybrids which continued to grow after they had been grafted exhibited a wide range of appearances. As others have observed, none of the plants completely resembled either the sugar beet or the wild parent, but almost all degrees of intermediate expression for most visible characteristics between the two parents could be found in the hybrids. This range was typical of leaf type and plant type. All hybrid plants bolted but only about 60 percent of them flowered. Pollen sterility appeared to be complete, as all anthers were entirely colorless. When supplied with an abundance of sugar beet pollen, 40 percent of the flowering plants did produce some normal appearing seed. This seed more closely resembled the seed of the wild parent than it did the sugar beet, in that it was borne in clusters of three which readily separated into single locule seeds upon ripening. The percentage of florets setting seed varied from less than one in some plants to over fifty in others. The viability of this seed, however, was extremely low. From approximately five-hundred seeds produced, only eight seedlings grew. Unfortunately, these, like the F_1 hybrids, would not grow to maturity on their own roots and required grafting for survival. The roots of these backcrossed plants, however, did show considerably more development than did the roots of the F_1 plants. In most of the backcrossed plants there had been some enlargement of the primary root and some development of secondary roots in well defined root zones. These secondary roots, however, became necrotic and to propagate the plants, they were grafted. All grafts attempted in these backcrossed plants were successful.

In appearance, these backcrossed plants were almost indistinguishable from sugar beets. The leaf shape was almost the same. Bolters in these backcrossed plants showed about the same degree of apical dominance that is shown by the sugar beet and there was no suggestion of a viny type of growth demonstrated by the wild parents. At this time there are several of these plants flowering but it is not known whether they will produce seed. In this generation there are appearing plants with very yellow anthers, however, it has not been possible to dissect pollen from them.

There has been a large amount of work done in recent years in California in the development of very slow bolting varieties. As the varieties

become more and more slow bolting, it becomes increasingly difficult to get complete participation and exact reproduction of these varieties in the seed fields. It appears that a point will be reached where the improvement by artificial selection for slow bolting will just about be nullified by the natural selection pressure in the seed fields toward the reproduction of the easier bolting segments of the varieties (3). Much is known as to the conditions required to induce bolting or seed stalk production; but almost nothing is known as to the nature or the action of the material that stimulates a sugar beet plant to change from the vegetative to the reproductive cycle. When this grafting technique became available, it offered a method by which one slight phase of this problem could be studied. Because the root stock is in the reproductive phase at the time the graft is made, it must possess sufficient of the stimulant material to induce and promote seed stalk development. An attempt was made to determine if this material, whatever it might be, would be transferred across the graft union and in what amounts. If the stimulus to produce a seed stalk was readily transferred across the graft union, it would provide a way of hastening the flowering process in extremely slow bolting breeding material that, at present, is extremely difficult to induce into flowering.

Three strains of sugar beets were selected on the basis of their bolting tendencies. They were classified as easy bolting, intermediate bolting, and very slow bolting. Seedlings of each were grafted onto a separate seed stalk in the manner described above. Six successful grafts were made of each class. They were kept in a warm greenhouse under conditions of natural day length. Under these conditions, normal biennial beets will not produce seed stalks. After about eight weeks, seed stalks began to appear in the grafts of the easy bolting strain and finally five out of the six grafts in that class produced a seed stalk. None of the grafts of the intermediate or very slow bolting strains showed any indications of developing a seed stalk. It seemed apparent then, that some of the stimulus for the development of a seed stalk is transferred across the graft union, but not in sufficient quantities to stimulate seed stalk production in sugar beet types that would be considered slow bolting.

While it appears that the three *Beta* species of the section, *Patellares*, are resistant to the attacks of the sugar beet nematode, almost nothing is known of the nature of this resistance. As previously pointed out, Gaskill has reported that F_1 hybrids between swiss chard and these wild species have shown resistance to the sugar beet nematode, while the swiss chard parent is susceptible. This could indicate that resistance is dominant. It is not known whether the substance or condition responsible for this resistance is a characteristic of the root itself or due to something manufactured in the leaves and subsequently translocated to the root. Assuming Gaskill's findings applied also to the crosses under discussion here, different graft combinations offered a method of casting some light on this problem. Because all grafts were made onto sugar beet plants, if nematode resistance or susceptibility was due to a characteristic of the root itself, it would make no difference whether sugar beet seedlings or the supposedly resistant F_1 seedlings were used for the scion, all plants would be susceptible. If, however, resistance was due to some substance manufactured in the leaves and translocated into the root, there should be a difference in nematode resist-

ance depending upon whether a sugar beet or F_1 hybrid seedling was used as a scion. Mr. George Wheatley, of the Sugar Section, Agricultural Research Service, U. S. Dept. of Agriculture, who is working on the sugar beet nematode problem consented to make the comparison between these two types of plants under heavily infested, controlled conditions in the greenhouse. At the end of his tests he could not determine any differences between the roots that had sugar beets grafted onto them and those that had F_1 hybrids for grafts. This would indicate that probably nematode resistance is a characteristic of the root itself.

Summary

A method of grafting is described by which a relatively high percentage of normally seedling lethal plants of inter-specific hybrids within the genus, *Beta*, can be propagated.

The F_1 plants of these interspecific crosses showed a wide range of variability between the two parents for most all visible characteristics; however, when these F_1 hybrids were backcrossed to sugar beet plants, the resulting progeny were almost indistinguishable from the sugar beet, except that they would still not grow on their own root and needed grafting for survival.

While the method of grafting was used here primarily to prolong the lives of F_1 hybrids and their backcrossed progeny, the method could have use in propagating clones of self-sterile sugar beets if so desired.

It was shown that some of the material associated with the stimulus that promotes the development of a seed stalk in sugar beets was transferred across the graft union, but not in sufficient quantities to cause slow bolting strains to bolt.

Indications were that the nature of the resistance to the sugar beet nematode is a characteristic of the root itself and not something that is manufactured in the leaves and later translocated into the root.

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Black Root of Sugar Beets as Influenced by Various Cropping Sequences and Their Associated Mycofloras

R. E. Deems and H. C. Young[1]

Summary

Black root of sugar beets at Hoytville, Ohio, during 1954-1955 was almost exclusively caused by *Aphanomyces cochlioides* Drechs. Soil was cropped to sugar beets during 1953-1954 to increase black root incidence. In May, 1955, sugar beets planted in soil from any portion of the plot became approximately 100 percent black rooted. Alfalfa, corn, oat, and sugar beets were cropped on this soil during 1955 and the soils assayed monthly for black root incidence and mycofloras. Cropping to corn and oat resulted in decreased black root. Corn was the most effective, decreasing disease incidence to 10 percent after three months and maintaining that level, or lower, through November. Oat decreased disease to 25 percent during the first four months, after which the oat was "plowed-down"; immediately black root increased to 76 percent and continued to increase through November. Alfalfa did not significantly decrease the amount of black root below the control sugar beet plots in which 95 to 100 percent of sugar beets black rooted at each monthly sampling from May through November.

There were several quantitative differences in the fungi isolated from the variously cropped plots. Increases and decreases in different fungi are correlated to black root incidence. It is probable that the effects of mycofloras on *A. cochlioides* are combination effects of the various fungi. Differences in associated mycofloras were primarily due to frequency of occurrence of fungi rather than to the presence or absence of specific fungi in any particular cropping sequence. Corn soil contained more of the following fungi than did alfalfa or sugar beet soils: *Penicillium funiculosum* Thom. *P. janthinellum* Biourge, *P. purpurogenium* Stoll, *P. rugulosumh* series Thom, *Trichoderma viride* Pers. ex Fr., *Absidia Butleri* Lendner, and other fungi of less striking differences. Several fungi occurred less frequently in corn soil than in alfalfa or sugar beet soils: *Vermicularia* sp. Fr., *Gliocladium catenulatum* Gilman et Abbott, *Sporotrichum* sp. Link, and other fungi of less striking differences. Oat soil differed from alfalfa or sugar beet soils primarily in the predominance of *T. viride* and *Aspergillus fumigatus* Fres. Alfalfa soils differed from corn, oat, or sugar beet soils in containing higher numbers of *Myrothecium verrucaria* (Alb. et Schw.) Ditm. ex Fr., *Ascochyta* sp. Lib., and *Fusarium merismoides* Corda; and in containing lower numbers of *A. fumigatus, Cephalosporium acremonium* Corda, *P. oxalicum* Thom, and *F. oxysporum* Schlect. Sugar beet soils differed primarily from the other soils in higher numbers of *Acrostalagmus,* spp. Corda and *Fusarium roseum* (g) Link. Possible explanations of the occurrence and effects of fungi associated with different cropping sequences were discussed.

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[2] Numbers in parentheses refer to literature cited.

Introduction

The possibility of controlling soil-borne pathogens by introducing specific antagonistic fungi to infested soils has been extensively investigated during the past four decedes. Antagonism has been readily demonstrated in diverse artificial cultures but attempts to reproduce such results in the field have been wholly unsatisfactory. A wide variety of diseases have been controlled by special crop sequences and by various organic and inorganic amendments. Empirically, such disease control has often been ascribed to effects on natural soil mycofloras relative to various pathogens (5, 11, 17, 18). Cropping sequences have received attention as methods of establishing desirable mycofloras. Total numbers of fungi have been correlated with special cropping effects on disease incidence. It is, however, difficult to understand the significance of total mycofloras in disease control. It seems much more logical to assume that control of specific pathogens should be associated with the increase or decline of specific members or groups of members of the mycoflora.

Coons and Kotila (2) reported that sugar beet black root was controlled if corn immediately preceded sugar beets in cropping sequences. Contrariwise, sweet clover or alfalfa immediately preceding sugar beets actually increased black root incidence. Several types of clover and alfalfa were later proven to favor the same fungi which incited black root (1). Soybeans and small grains were found to decrease black root. Clovers and alfalfa could safely precede sugar beets if they were "plowed-down" early enough to allow "adequate disintegration of residues." Coons suggested that these controls were effected by competition and succession of non-pathogenic fungi.

That the basic control mechanisms of specific cropping sequences were ascribable to associated mycofloras was indicated by Kommendahl and Brock (10). They analysed soil which had been monocropped to corn, or oat, or wheat for 38 years for numbers of fungi. In this stabilized situation *Aspergillus fumigatus* Fres. was the most abundant fungus isolated from oat soil. Isolates of this fungus controlled seedling blight of corn incited by *Gibberella zeae* (Schw.) Petch. Gibberella seedling blight was also controlled when corn was planted in oat soil. In artificial culture, wheat was protected from seedling blights incited by *Fusarium* spp. Link ex Fr. by the following fungi in the order listed: *A. clavatus* Desm., *Penicillium* sp. Link ex Fr., *Trichoderma lignorum* (Tode) Harz., *P. lilacinum* Thom, *Nigrospora* sp. Zimm., *Penicillium* sp., and *A. fumigatus*. Herr (8) more thoroughly investigated the mycofloras associated with corn, oat, and wheat in these same continuously cropped plots. Four kinds of fungi predominated: *A. fumigatus, P. funiculosum* Thom, *Trichoderma* spp. Pers. ex Fr., and *Fusarium* spp. Striking differences in the frequency of these fungi were apparent. *A. fumigatus* was the predominant fungus from oat plots; *P. funiculosum* was the predominant fungus from corn plots; while *Trichoderma* spp., *Fusarium* spp., and *A. fumigatus* occurred with equal frequency in the wheat plots. *Trichoderma* spp. were never isolated from the oat plots.

The purpose of this study was to establish whether different characteristic mycofloras developed during one season's cropping to alfalfa, corn, oat, and sugar beets following two seasons of sugar beets and to correlate such differences, if they occurred, with the effects of these crops on black root incidence.

Materials and Methods

To insure adequate increase of black root, an 86 foot by 172 foot plot of Brookston Clay was planted to sugar beets at Hoytville, Ohio, in 1953. This same plot was planted to sugar beets in 1954 and assayed weekly, from May 6 through September 9, for soil mycoflora and black root incidence. At the end of this period, approximately 100 percent of the sugar beets seeded in soil from any portion of the plot became black rooted. This plot was divided into twelve 44 foot by 14 foot plots in the spring of 1955 and planted to alfalfa, corn, oat, and sugar beets. The soil mycoflora and black root incidence in each plot were assayed monthly using the following methods. Aseptic techniques were used throughout.

Each plot was randomly sampled by taking eight 1 inch by 3 inch cores perpendicular to and including the surface. These eight cores were thoroughly mixed by grinding and agitation. The amount of moisture in each sample was determined using a 100° C. oven.

Black root was assayed by planting segmented sugar beet seeds in a portion of each pooled sample and counting the diseased seedlings after three weeks. Diseased seedlings were cultured for black root pathogens. To determine the number of seedlings diseased with *Aphanomyces cochlioides* Drechs., seedlings were washed thoroughly, blotted of excess water, placed in sterile distilled water, and later examined.

Soil fungi were isolated by a soil dilution plate technique (14). Samples of the pooled soil were suspended in a 1 percent CMC[3] solution with a mechanical stirrer and diluted 1:10,000. One ml aliquots of this final dilution were added to each of 16 petri dishes. Ten ml of a medium developed at the Ohio Agricultural Experiment Station (see Table 1), maintained at 52° C, were placed in each plate, the cultures mixed, and then incubated

Table 1.—Culture Medium Developed at the Ohio Agricultural Experiment Station for the Isolation of Saprophytic Soil Fungi.

Agar	20.0 g
Yeast Extract	2.0 g
Sodium Nitrate	1.0 g
Potassium Phosphate (monobasic)	1.0 g
Magnesium Sulfate	0.5 g
Glucose	5.0 g
Oxgall	1.0 g
Sodium Propionate	1.0 g
Streptomycin	50.0 mg
Chloromycetin	50.0 mg
Distilled Water	1,000.0 ml

Autoclave at 11 pounds pressure for 15 minutes

at 24° C. for 5 days. After incubation, fungal colonies were marked and each fungus identified as soon as possible. If a fungus could not be classified to a well recognized category, it was named to the best of the author's ability and constantly there assigned on reoccurrence. Subsequently, most of these colonies were correctly identified. Several "keys" to the fungi were used in this research (3, 4, 6, 7, 13, 16).

The kinds and total numbers of fungi were tabulated for each replication of each crop and recorded as the numbers per gram of oven dried soil to facilitate comparisons.

[3] CMC = 120 High Viscosity Carboxy-methyl cellulose, Hercules Powder Company, Wilmington 99, Delaware.

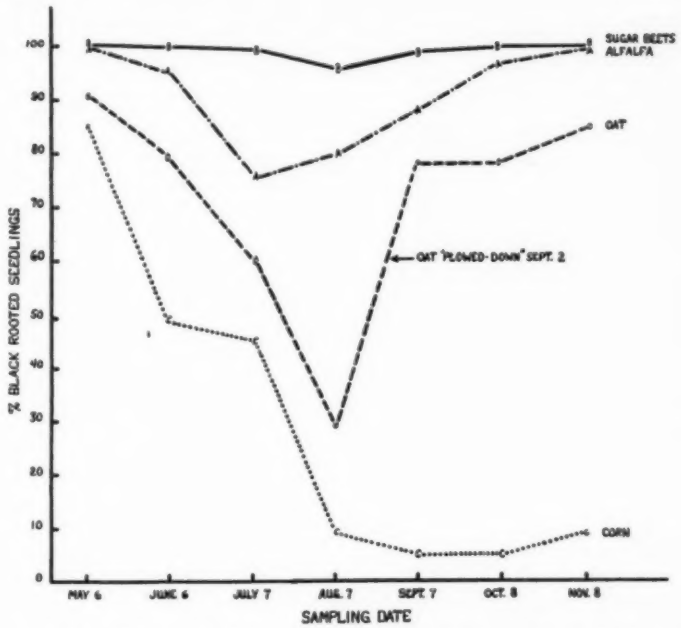

Figure 1.—Incidence of black root pathogens in sugar beet soil (2 years) cropped to alfalfa, corn, oat, and sugar beets at Hoytville, Ohio, during 1955.

Results

Pathogens causing black root.

Black root incidence is a limiting factor in sugar beet production in Ohio. The disease has most often been attributed to *A. cochlioides, Rhizoctonia solani* Kuhn, and *Pythium* spp. Pringsheim. Investigation of the cause of black root during 1954 and 1955 established that the disease was almost exclusively incited by *A. cochlioides.* Of 2,548 diseased seedlings examined, *A. cochlioides* was cultured from 2,487, *Fusarium* spp. from 34, *R. solani* from 12, and various other organisms from 15. A bacterium tentatively identified as *Erwinia caratovora* (L. R. Jones) Holland was usually associated with *A. cochlioides.* This bacterium incites a soft rot of sugar beet tissues when introduced but does not appear to be a primary invader.

Effects of cropping sequences on black root incidence.

Striking effects on black root incidence resulted from cropping soil thoroughly infested with black root pathogens to alfalfa, corn, oat, and sugar beets (see Figure 1). Sugar beets maintained a 95 to 100 percent inoculum potential in the soil throughout the season. Alfalfa slightly decreased black root during May and June, but thereafter steadily increased black root through November. Oat steadily decreased black root to 25 percent through the August 7 sampling. "Plowing-down" of oat September 2 resulted in an increase in black root to 76 percent at the September 7

sampling date. Black root increased through the succeeding sampling dates. Corn was the most effective crop, decreasing black root to 10 percent after three months and maintaining that level, or lower, through the remainder of the season.

Effects of cropping sequences on soil mycofloras.

In May of 1955, when the soil was seeded to alfalfa, corn, oat, and sugar beets, the mycoflora was little different from that established for the plot during 1954. There were also little differences between the mycofloras of the plots seeded to alfalfa, corn, oat, and sugar beets. Throughout the growing season of 1955, the differences between mycofloras could, therefore, be attributed to the different crops or associated agronomic practices. Generally, the same kinds of fungi were isolated from all the plots in 1955. The principal differences between treatments were in the frequencies of the different types of fungi.

One season's cropping of sugar beet soil to alfalfa, corn, oat, and sugar beets had little effect on the total numbers of fungi isolated (see Table 2). There were no important differences in numbers of fungi associated with the different crops; except in case of alfalfa and oat at the October 8 sampling and oat at the September 7 sampling. The low number of fungi associated with alfalfa at the October 8 sampling can be attributed to no known factor. In the case of oat, the extremely high number of fungi at the September 7 sampling immediately followed "plowing-down" of the crop. The entire difference was due to an epidemic of two species of Fusarium: *F. lateritium* Nees v. *minus* Wr. and *F. avenaceum* (Fr.) Sacc. The sharp decrease in total numbers at the next sampling was primarily due to a complete absence of these two Fusaria. The variability in total numbers (Table 2) is probably due to differential availability of moisture.

Table 2.—Total Fungi[1] in Sugar Beet Soil (2 yrs.) Cropped to Alfalfa, Corn, Oat and Sugar Beets at Hoytville, Ohio, During 1955 (Each Number is the Average of 3 Replications).

Crop	Sampling Date							Av. No. of Fungi During Season
	May 6	June 6	July 7	Aug. 7	Sept. 7	Oct. 8	Nov. 8	
Sugar Beets	128.8	81.8	55.5	80.3	106.4	100.4	114.0	95.3
Alfalfa	108.4	71.2	34.4	88.4	89.0	50.6	133.3	82.2
Corn	134.3	75.3	57.5	101.0	89.6	111.2	137.3	100.9
Oat	96.6	69.8	34.6	81.6	207.6[2]	42.6	77.7	87.2

[1] Thousands of Fungi per gram of Oven-Dried Soil.
[2] Of this total, 119.4 are Fusarium avenaceum and Fusarium lateritium var. minus.

During 1955, 145 different species of fungi belonging to 85 different genera were isolated from the plots. It is noteworthy that 60 to 80 percent of the fungi isolated at any one sampling were *Aspergillus* spp., *Gliocladium* spp., *Fusarium* spp., *Penicillium* spp., and *T. viride*.

Fungi isolated from oat plots are not directly comparable with those from alfalfa, corn, and sugar beet plots after the August 7 sampling. *A. fumigatus* and *T. viride* were more abundant in oat soil than in alfalfa or sugar beet soils. This difference may partially account for decreased black root in oat soils up to "plowing-down." More importance should probably

be placed on the early predominance of *F. equiseti* (Corda) Sacc. and *F. episphaeria* (Tode) Snyder et Hansen in oat soil. These two Fusaria are important components of grassland soils. They are excellent colonizers of organic materials and possibly competed more successfully for nutrients than did *A. cochlioides.*

Corn most effectively reduced black root incidence, whereas alfalfa and sugar beets did not. Correlations between corn soil vs. alfalfa and sugar beet soils are possible. Various fungi occurred in different numbers in corn soil than in alfalfa and sugar beet soils. Several fungi were strikingly higher in corn soil. *Penicillium* spp. were most distinctive in this respect with *P. funiculosum, P. janthinellum* Biourge, *P. purpurogenum* Stoll, and *P. rugulosum* series Thom being outstanding. *Absidia Butleri* Lendner, *Robillardia* sp. Sacc., *Geotrichum candidum* Link, *Spicaria divaricata* (Thom) Gilman et Abbott, and *T. viride* were also more abundant. Those fungi which occurred less in corn soil were *Vermicularia* sp. Fr., *Phoma* sp. Desm., *Gliocladium catenulatum* Gilman et Abbott, *Hyalopus ater* Corda, *P. nigricans* Bain., *Sporotrichum* sp. Link, *Pullularia pullulans* (deBary) Berkhout, *Alternaria tenuis* Nees, *Fusarium* spp., and *F. solani* (Martius) Appel et Wollenw.

The organisms favored by cropping to alfalfa were *Myrothecium verrucaria* (Alb. et Schw.) Ditm. ex Fr., *Ascochyta imperfecta* Peck, and *F. merismoides* Corda. *M. verrucaria* is noted as an important cellulytic fungus of

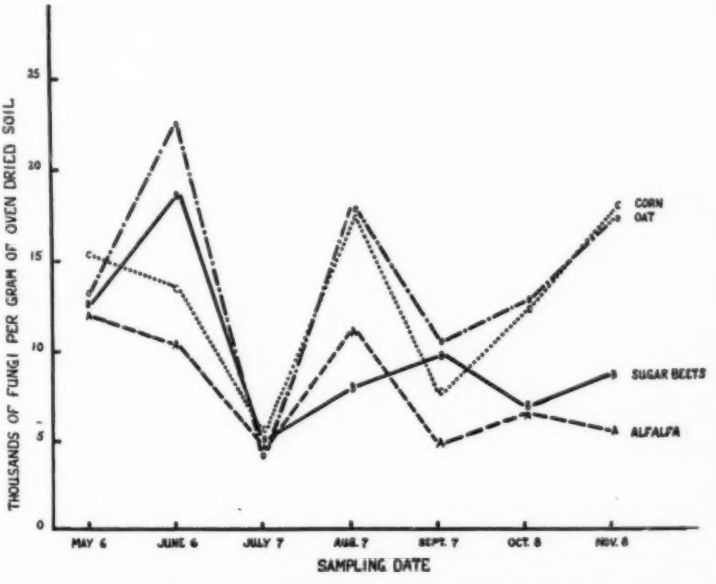

Figure 2.—Occurrence of *aspergillus fumigatus* and *trichoderma viride* in sugar beet soil (2 years) cropped to alfalfa, corn, oat, and sugar beets at Hoytville, Ohio, during 1955.

cosmopolitan distribution. The presence of debris containing high amounts of cellulose in the alfalfa plots late in the season may account for its increase. Blackstem of alfalfa was common in the plots late in the season accounting for the increased *A. imperfecta*. Those fungi decreased by alfalfa were *A. fumigatus*, *Cephalosporium acremonium* Corda, *P. oxalicum* Thom, and *F. oxysporum* Schlecht. *Fusarium conglutinans* Wollenw. occurred predominantly in sugar beet soil. No attempt has been made to prove the pathogenicity of this fungus; but a variety is known to be the causal agent of sugar beet yellows. *Acrostalagmus* spp. Corda and *F. roseum* Lk. (g) were also higher in sugar beet soils. *R. solani* and *Pythium* spp. were isolated infrequently due to the method used. These two organisms were, however, consistently obtained from soil samples when special isolation procedures were used.

Occurrences of the four fungi best correlatable with decrease of black root at various samplings are illustrated in Figures 2, 3, 4, and 5. *Penicillium* spp. continually increased through the season in corn soils (see Figure 3). The two species most responsible for this increase late in the season were *P. funiculosum* (see Figure 4) and *P. janthinellum* (see Figure 5). *P. purpurogenum* and *P. rugulosum* series were important fungi early in the season. The occurrence of *A. fumigatus* and *T. viride* is illustrated in Figure 2. In general, there was a greater frequency of the latter two organisms in corn and oat soils than in alfalfa and sugar beet soils. The seasonal variations of

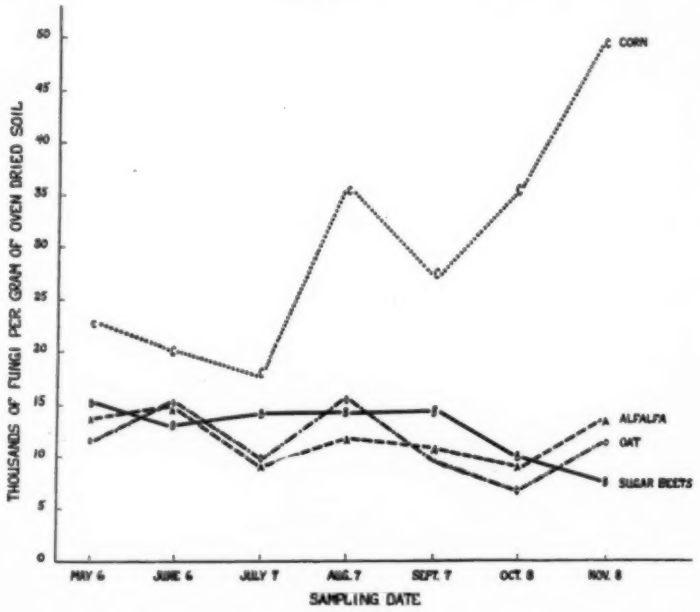

Figure 3.—Occurrence of *penicillium* spp. in sugar beet soil (2 years) cropped to alfalfa, corn, oat, and sugar beets at Hoytville, Ohio, during 1955.

these four organisms do not obscure the definite relationships. Even with fluctuations, the fungi remain in the same relative order in the variously cropped soils. Such seasonal fluctuations were common with most of the genera identified.

Discussion

There has been considerable question by various investigators concerning the establishment of characteristic different mycofloras by various crops. Herr (8) proved that mycofloras were different when corn, oat, and wheat were continuously cropped for 39 years. There is little doubt, from the present investigation, that characteristic different mycofloras may develop in one season. In fact, the mycofloras become different early in the development of the crops. Cropping influences are stronger than impinging environments since similar relationships in frequency of specific organisms were maintained through the season. There was little difference in mycofloras during the latter samplings in 1954 and that at planting time in 1955, but is this the normal? A strikingly different situation was the share increase of black root when oat was "plowed-down" September 2. The desirable effect on black root was immediately negated. Certainly the mycoflora was critically disturbed. *F. avenaceum* and *F. lateritium* v. *minus* were probably introduced from above ground portions of oat plants. *Penicillium* spp. decreased as did several other genera.

The majority of saprophytic soil fungi in Ohio apparently belong in 6-10 genera with a large number of minority inhabitants and invaders. The

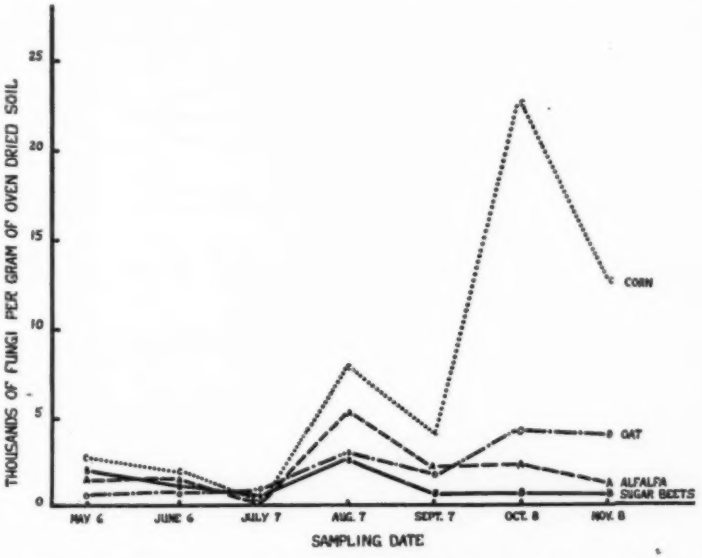

Figure 4.—Occurrence of *penicillium funiculosum* in sugar beet soil (2 years) cropped to alfalfa, corn, oat, and sugar beets at Hoytville, Ohio, during 1955.

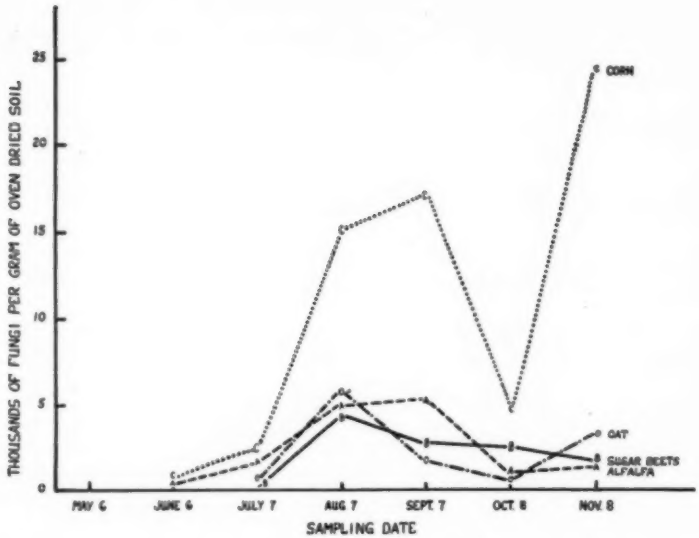

Figure 5.—Occurrence of *penicillium janthinellum* in sugar beet soil (2 years) cropped to alfalfa, corn, oat, and sugar beets at Hoytville, Ohio, during 1955.

primary concept to be recognized is that while genera may vary in occurrence, this variability is due to differences in numbers of individuals of species and varieties. Such species and variety differences are of primary importance in mycoecology.

The slight early decrease of *A. cochlioides* disease potential in alfalfa soil followed by an increase to 100 percent is quite interesting since *A. cochlioides* has never been proven pathogenic to alfalfa. It is possible that some organisms or groups of organisms are antagonistic to an organism or group of organisms antagonistic to the pathogens. *P. funiculosum, P. janthinellum, P. purpurogenum,* and *P. rugulosum* series may be considered antagonistic to *A. cochlioides.* These species occur infrequently in alfalfa and sugar beet soils and have, in general, an intermediate occurrence in oat soils. A *Vermicularia* sp., *G. catenulatum,* and a *Sporotrichum* sp. occur in precisely the opposite pattern. It is possible that the latter organisms are antagonistic to the *Penicillium* spp. Therefore, *Penicillium* spp. do not increase to a level where they are antagonistic to *A. cochlioides.*

Correlations, such as those described in the present investigation, may indicate "biological control" by fungi such as *Penicillium* spp., *Aspergillus* spp., *T. viride, Fusarium* spp., or others. The soil fungi are in a state of equilibrium with their environments. Various cropping sequences and soil amendments favor development of different members of the soil population.

Different fungi increase at the expense of other fungi. The principal mechanisms are probably antibiosis and differential competition for available nutrients. Differential cropping is an effective means of varying mycofloras. Results reported here are not yet conclusive; however, an understanding of the mode of black-root control by crop sequences is indicated.

Members of the soil population other than fungi are undoubtedly important in "biological control." Actinomycetes, bacteria, nematodes, and protozoa are also probably differentially influenced by cropping sequences. Any change in the soil population may affect pathogens differentially. This program, at present, concerns only fungi. The belief is that the more completely the soil population is understood, the more intelligently and, therefore, more effectively can root rot problems be solved.

Several factors are important in establishment of characteristic mycofloras. Differences depend on competition, antagonism, antibiosis, or parasitism among the component fungi. The degree and type of differences may be conditioned by: (a) Agronomic practices peculiar to each crop; (b) quantity and quality of crop debris returned to the soil during the growth of and after the death of individual crops; (c) different growth habits of plants such as transpiration rates, type of root system, quantity and type of materials removed from the soil by plants, and root diffusates; (d) pH; (e) temperature; (f) moisture; and (g) physical qualities of the soil.

Inasmuch as the soil mycofloras are probably associated with multitudes of microhabitats near various substrates, it is quite possible that antibiotics could be an important factor in the distribution of many types of fungi. Certainly many strains of fungi are capable of producing antifungal antibiotics. Diffusates which accelerate the growth of fungi may also be important. Such conditions probably occur in the soil and the quantity of effective antibiotic or acceleratory substances could be relatively small if concentrated at limited loci. Pramer and Starkey (12) have indicated that the quantities of antibiotics necessary for action in the soil are much higher than in in vitro research. Furthermore, antibiotics are often unstable in some soils. Such research has not been sufficiently investigated on a micro-scale.

Strains of several fungi isolated in this investigation are capable of producing antifungal antibiotics (see Table 3). Three of the antibiotics are effective against Phycomycetes (9). The authors are of the opinion that mechanisms involving antibiotics are partially responsible for the occurrence of different mycofloras and may be effective in controlling soil borne pathogens.

The soil-dilution plate technique used in this investigation has been proven quite satisfactory for the type of study described. The method does favor isolation of sport producing fungi; but this is not disadvantageous since the drawback is recognized. Close agreement between members of similar samples emphasizes the reliability of the method. Accuracy of the procedure continges upon proper sampling and thorough mixing. Too much care cannot be exercised in identifications. The fungi listed in this research were all identified by one investigator and constancy has been emphasized throughout.

Table 3.—Some Antibiotics from Soil Fungi of Possible Importance in These Investigations.

Antibiotic	Organism	Biological Activity
Expansine	Aspergillus clavatus, A. terreus	Many Phytopathogens—Pythium spp., Ceratostomella ulmi, etc.
Gliotoxin	Gliocladium catenulatum (= G. fimbriatum) Trichoderma viride (= all yellow and green T's) Aspergillus fumigatus	Inhibits Claviceps purpurea, Phytophthora erythroseptica, Sclerotinia sclerotiorum, and Stereum purpureum
Aspergillic Acid	Aspergillus flavus	Inhibits Phytophthora erythroseptica, Pythium ultimum, etc.
Glutinosin	Myrothecium verrucaria	Inhibits Phoma betae, Mucor mucedo, and other fungi
Viridin	Trichoderma viride	Inhibits Botrytis allii, Cephalosporium sp., Fusarium coeruleum, F. culmorum, Stachybotrys atra, Penicillium spp., Trichothecium roseum, and other fungi
Trichothecin	Trichothecium roseum	Inhibits some Fungi
Uncharacterized	Penicillium citreo-viride, P. funiculosum, P. nigricans, P. oxalicum, and Scopulariopsis sp.	Inhibits some Fungi

Significant levels have not been completely established for these data. Investigators at the OAES (15) have evidence that differences of 60 to 100 percent are significant for total numbers of fungi. We are using this level at present to judge significance between genera. Recent results indicate that lesser differences may be significant for genera.

A type of mycoflora associated with a soil which has a low incidence of black root has been described. The authors believe that assays such as these could be used to predict black root free soil. More supplementary data are necessary for several different soils before such analyses are practicable. These data are also preliminary to an understanding of the basic control mechanisms operative in desirable cropping sequences.

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Metering Devices and Test Results of Some Foreign and Domestic Sugar Beet Planters[1]

R. D. BARMINGTON[2]

Precision planting of sugar beet seed is a goal that research men in this industry have had for a long time. If the seed could be made large, smooth, and dense, the problem of precision planting would be greatly reduced. This immediately suggests pelleting as the answer to all planting problems. Unfortunately, pelleting introduces new problems while it helps to solve the original problem of distribution. Since we are dealing with a seed that is not uniform in size, shape, or density, it is difficult to imagine a mechanical device flexible enough to plant non-uniform particles in a strictly uniform pattern.

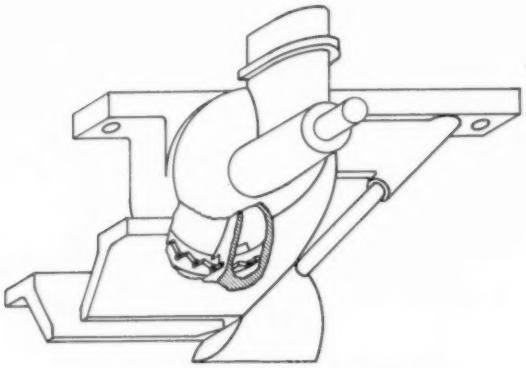

Figure 1.—Cut-away drawing of the Taxigraine planter showing part of the seed-metering plate and furrow opener.

Seed Damage and Distribution

The problems of precision planting have indicated that a search for new ideas might be in order. In addition to accurate spacing of seeds the damage to seeds from breaking and grinding must be kept to a minimum. In conventional planters there is damage done to the seed at the point of cut-off where the seed in the plate leaves the main body of seed in the hopper. To overcome this problem there seems to be two possibilities: (a) Make the seed plate fill with seed and pass out of the seed body in such a way that no cut-off is necessary, or (b) make the cut-off so flexible and gentle that seed will not be broken. In the first case the seed cells can be filled while traveling in an upward direction through the seed body, then through a confined passage to the point of discharge. The 1951 Taxigraine and Ventura planters

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use this type of metering device. The greatest trouble with this system is to get the cells to fill without skips or more than one seed per cell. Seed damage was practically zero with this system but distribution was poor especially in the Ventura planter.

In the second case some planters using rubber belts for metering devices have been tested with some interesting results. The English-made

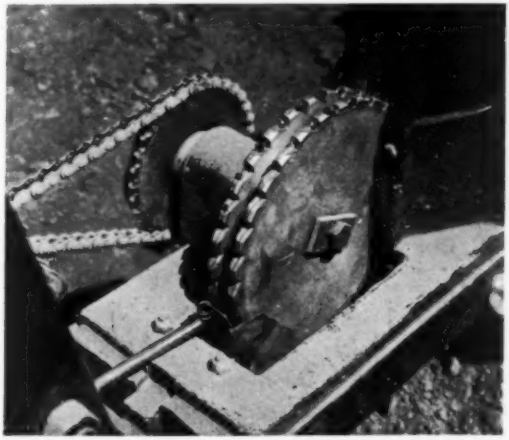

Figure 2.—Seed plates of the Ventura planter with the plastic cover removed to show the plates and cell arrangement.

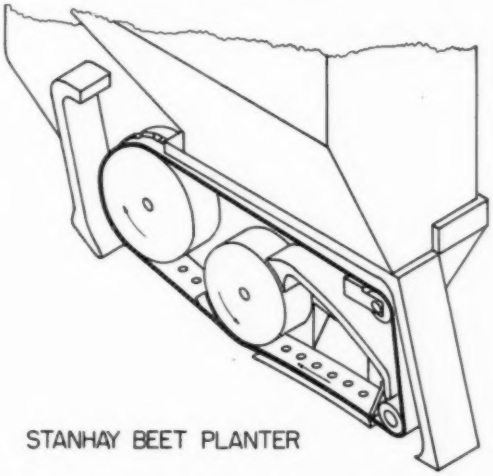

Figure 3.—A drawing of the Stanhay planter showing the method of seed metering with a flat rubber belt and rotating seed cut-off wheel.

Stanhay planter uses a very flexible rubber belt with seed cells that perforate the belt. A rubber-faced, cut-off wheel, which rotates in a direction opposite

Figure 4.—General view of the Semora planter unit showing the drive for the seed belts and the agitator and the shoe-type furrow opener.

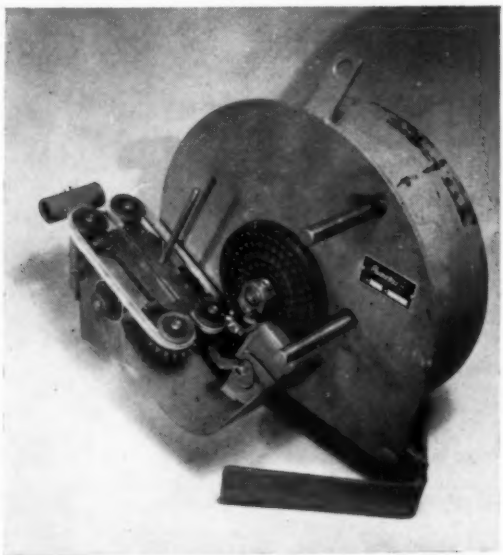

Figure 5.—View of the Semora seed belts with the seed hopper removed.

to the direction of belt travel, wipes off any excess seed from the seed belt. The Swiss-made Semora planter uses two soft rubber belts in another way to meter the seed. Seed is grasped between them after it has been lined in a single row by a slot in a thin metal plate. This machine does not have definite seed cells. The seeds are dropped off the end of the rubber belts in a continuous row. Spacing in the row is controlled by the speed of the belts in relation to the ground.

Both of these rubber-belt machines handle the seed very gently and cause no seed damage. Distribution from the Stanhay is very good while the Semora gives rather poor distribution since there is no positive mechanical ejection from the metering belts.

Laboratory Technique

A comparison of distribution results can best be made with numerical terms. A system of measurement was developed, based upon the following assumptions: (a) Half of the seeds dropped in a most crude manner, either by hand or machine, would fall in the desired place, regardless of seeding rate; (b) with the above assumption, planters which place only half of the seeds in their theoretically calculated position would have a rating of zero and would not be considered a precision machine. Planters which place all of the seeds in the proper position would have a rating of 100. A planter should be penalized for planting seeds too close together and for skips (seeds too far part).

The method of evaluation based on 100 seed intervals is as follows: For simplicity, a theoretical seeding rate was assumed. That rate was one seed per inch and 100 inches of row distribution. For seeds one inch apart a positive value of 1 was assigned. If a seed was ½ of a seed interval from the last seed counted (in this case ½ inch), it was still given a positive value of 1. If the distance was less than ½, a negative value of 1 was assigned. This penalized the planter for too many seeds and for bunching of the correct number of seeds. Further penalty was placed on the planter for long skips. For each space of more than 1½ seed intervals (1½ inches in this case), a negative value of 1 was assigned.

All the positive values and all the negative values were added and the difference was the score for that particular machine. The highest score possible was 100 and a poor planter would have a negative value which is too poor to be classed as a precision planter according to the original premise. Corrections must be made for different seeding rates. If the theoretical seed spacing is 2½ inches, for instance, the final score would be multiplied by 2½, etc., to keep the score comparable regardless of the seeding rate. A greased board was used to catch the seed as it came out of the planter shoe in the same relative position as the bottom of the seed furrow. A greased board proved satisfactory for this study since the seeds remained exactly where they fell.

The system described has been used in the laboratory with all our planters for the past two years. The system is a critical measure but has been satisfactory and is relatively easy to use.

Laboratory Results

From the distribution point of view, the Stanhay and Taxigraine planters rate at the top of the list. Changing the seed cut-off in the Milton planter to a spring-loaded type raised the score for this machine. The poor distribu-

tion from the Milton planter using a fixed cut-off appeared to be caused by a wedging of seed into the cells and the throwing effect of the knock-out as these seeds are forced out. The low score for the Semora planter probably is caused by the lack of a positive mechanical discharge at the end of the

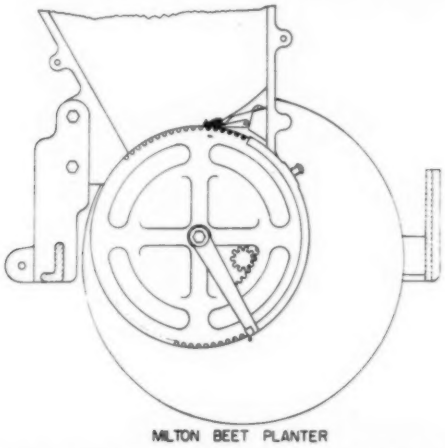

Figure 6.—Right hand disc removed from the Milton planter to show the seed plate and the position of the seed discharge.

rubber belts and also by the agitator which is used in the hopper. Changes made in the false bottom of the John Deere seed hopper raised the score for this machine materially but these changes required very careful hand fitting and adjustment which probably would not be possible from the manufacturer's standpoint. No score was made for the Ventura planter since bunching of the seed was so apparent that it was not considered worthwhile.

Cell-fill data, seed damage figures, and distribution scores are shown in Table 1. The measure of damage shown in the table was determined by the percent of seed, by weight, which passed through a 6/64-inch, round-hole screen. All of the original seed was passed over a 7/64-inch, round-hole screen. In some cases germination has been depressed 8 percent by passing through a planter. Some dust always rubs off the seed and if this amounts to less than one percent it may be assumed that no real harm has been done in passing through the metering device. Vertical plates arranged so no cut-off was necessary and a rubber belt, or belts, caused no measurable damage to the seed. Plate speeds and cell sizes were chosen to give an approximate average fill of one seed per cell.

Field Results

Field results are the final measure of the performance of any sugar beet planter. Most of the planters mentioned, with the exception of the Semora, have been used in the field more than one year. The Semora was

Table 1.—Laboratory Planter Performance.

Planter	Metering Equipment	Av. No. Seeds Per Cell	Percent Seed Damaged	Distribution Av. Score
Stanhay[1]	Rubber Belt 11/64" Diam. Cells	0.869	Nil	32.75
Stanhay[1]	Rubber Belt 3/16" Diam. Cells	1.07	Nil	54.89
Milton	Old Cut-Off, 240 Cells, Sixe 10-9-9	1.10	13.09	—42.53
Milton	New Cut-Off, 240 Cells, Size 10-9-9	1.04	10.52	16.63
Semora	Two Rubber Belts		Nil	—12.24
Taxigraine[2] (1951 Model)	36 Cell Vertical Plate	1.03	0.54	30.84
John Deere No. 64	11/64" Diam. Cells	0.994	2.97	9.51

[1] Maximum speed for satisfactory cell fill and distribution 2.5 MPH.
[2] Cell fill and distribution fairly uniform from 1.4 to 5.3 MPH.

Figure 7.—General view of some of the beet planters used in the 1955 field test. Left to right the planters are Ventura, Stanhay, Semora and Milton.

obtained from Switzerland and used for the first time in 1955. The modified John Deere was compared only in the 1955 test but John Deere planters with the same hoppers have been used for a number of years. Table 2 shows field results in 1954 and 1955. Care must be taken in comparing a given planter from one year to the other for two very good reasons. In 1954 commercial segmented seed was used and nearly ideal growing conditions

prevailed. In 1955 monogerm seed was used and very poor germinating conditions existed. The field on which 1955 tests were conducted was irrigated four times but still it dried out and cracked too fast to permit good germination.

Table 2.—Field Planter Tests. Seed: 1954—Segmented 7 to 10/64 inch—Germination 91 Percent. 1955—Monogerm 7 to 10/64 inch—Germination 76 Percent.

	Percent Singles		Percent Doubles		Percent Multiples		Percent Emergence	
Planter	1954	1955	1954	1955	1954	1955	1954	1955
Taxigraine	47.1	74.7	32.8	21.5	20.1	3.8	70.5	58.7[1]
Stanhay	47.3	86.7	37.9	12.6	14.8	0.7	70.4	51.8
Milton	48.0	91.6	30.7	8.0	21.2	0.4	52.7	33.6
Ventura	45.8	75.0	30.9	22.1	23.2	2.9	64.3	36.8
John Deere No. 55 Modified		87.5		10.7		1.8		34.0
Semora		82.6		16.2		1.2		59.8

[1] 1955 Beets from the Taxigraine were larger than from any other planter.

Discussion of Results

A few results are notable. In 1955 the beet seedlings from the Taxigraine were larger and more vigorous in appearance than from any of the other planters. This was attributed to the type of shoe opener and presswheel used on this machine. The blunt opener used worked well in a good seed bed but may cause trouble when used under trashy seed bed conditions. The presswheel is rather narrow and heavy and runs directly over the seed. In 1955 there was a marked increase in percent singles and a decrease in double and multiple plants. This was caused largely by the use of monogerm seed and influenced to some extent by poor germinating conditions. In both 1954 and 1955 the Stanhay and Taxigraine planters were relatively high in percent emergence. For some unknown reason the percent emergence from the three foreign planters was appreciably higher than from the three domestic planters in 1955.

Future Plans

We have some new designs in mind which we hope to develop and test before monogerm seed comes into general use. Some of the different principles observed in the imported planters will serve as a guide in our thinking. For the most part the foreign-made planters are not as rugged as American-built machines. This might present a problem of maintenance if the foreign machines were used by our beet growers. The three foreign planters tested represent only a small sample of the many available from other lands and wider search may reveal more and better ideas.

The success of mechanical thinning depends to a large extent upon a uniform stand of vigorous seedlings. Uniformity of stand is more important than numbers of seedlings. The planter is largely responsible for the stand through accurate placement of seed and high emergence assuming that the seedbed is properly prepared. Anything we can do to improve the quality of seedling stands will be reflected in dollars saved at thinning time and higher profits at harvest time.

Comparison of CO_2 and $NaHCO_3$ as Extractants for Measuring Available Phosphorus in the Soil

BION TOLMAN, RONALD JOHNSON, AND ROBERT S. GADDIE[1]

Since 1949 the Utah-Idaho Sugar Company has been using the CO_2 method to determine available phosphate levels in soils and to place soils in four basic groups in making recommendations for the use of phosphate fertilizers. (3) (4)[2]. The limits set for the four groups are:

0— 5 ppm PO_4—Very Low—	120 pounds P_2O_5
6—15 ppm PO_4—Low—	80 pounds P_2O_5
16—25 ppm PO_4—Medium—	40 pounds P_2O_5
Above 25 ppm PO_4—High—	No added phosphate

It will be noted from the above that recommended phosphate applications varied from 0 to 120 pounds of P_2O_5 per acre depending on the available level of phosphate as indicated by the CO_2 test. In most of the areas in which the Utah-Idaho Sugar Company operates, recommendations based on the above schedule proved quite satisfactory. There were, however, some areas where discrepancies were rather frequent and where available phosphate levels appeared to be lower than was born out by field tests. Belle Fourche, South Dakota, was one of these districts.

In 1954 Sterling Olsen published a report on the use of $NaHCO_3$ as the extracting agent and gave extensive comparisons between this method, the CO_2 method and several others. Mr. Olsen's report indicated that the $NaHCO_3$ method was applicable to a wide variety of soil types and soil conditions, and that the results correlated well with crop response. (1) (2).

In view of these facts the Utah-Idaho Sugar Company decided to adopt the $NaHCO_3$ method and during the 1954 season soil samples were run by both the CO_2 and $NaHCO_3$ methods. Field trials were also run to establish response levels on sugar beets in the various areas where the company operates.

This paper is a report of the comparisons made, the phosphate levels found in Utah, Idaho, Washington, and South Dakota, and the phosphate fertilizer recommendations made on the basis of these tests.

Experimental Results

A comparison of available phosphate levels in several states as shown by the two methods of analysis is shown in Table 1 and Figures 1, 2, 3, 4. It will be observed that the percentage of soil samples falling in the classes of "low" and "medium" were essentially the same for both methods of analysis. In fact, the two methods gave very similar classification as to phosphate levels in all states except South Dakota. In South Dakota the CO_2 method of analysis showed that available phosphate level in 32 percent of the soils sampled was "very low." However, when the $NaHCO_3$ method of analysis was used, only 1 percent of the samples fell into the "very low" class. By the CO_2 method only 3 percent of the soil samples from South Dakota rated in the "high" class. The $NaHCO_3$ method showed 28 percent of the soil samples in the "high" class. This percentage with adequate

[1] General Agricultural Superintendent, Research Assistant, and General Chemist of Utah-Idaho Sugar Company, Salt Lake City, Utah.

[2] Numbers in parentheses refer to literature cited.

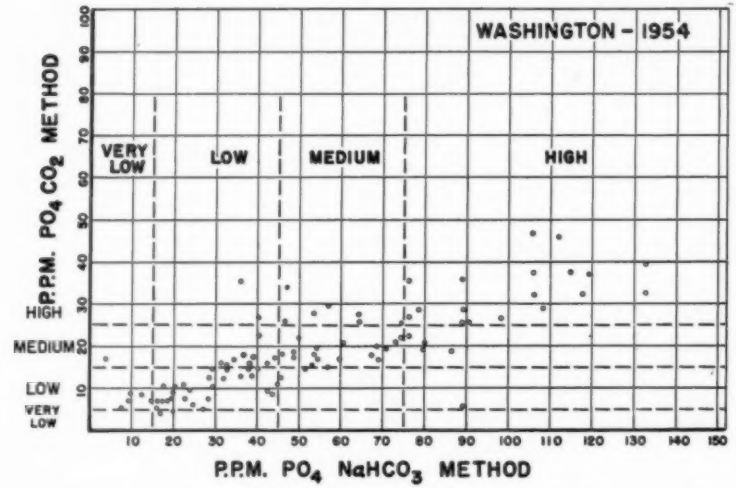

Figure 1.—This figure shows the parts per million of PO_4 from Washington soils as determined by the CO_2 method and calibrated along the left side of the chart and the $NaHCO_3$ shown along the bottom of the chart. Note that although the parts per million is approximately three times as large when determined by the $NaHCO_3$ method as when determined by the CO_2 method, there is nevertheless a close correlation between the two.

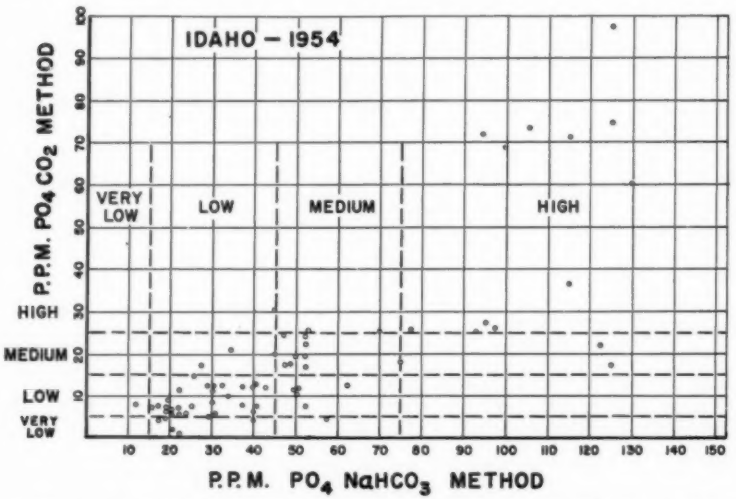

Figure 2.—This figure shows the parts per million of PO_4 from Idaho soils as determined by the CO_2 method and calibrated along the left side of the chart and the $NaHCO_3$ shown along the bottom of the chart. Note that although the parts per million is approximately three times as large when determined by the $NaHCO_3$ method as when determined by the CO_2 method, there is nevertheless a close correlation between the two.

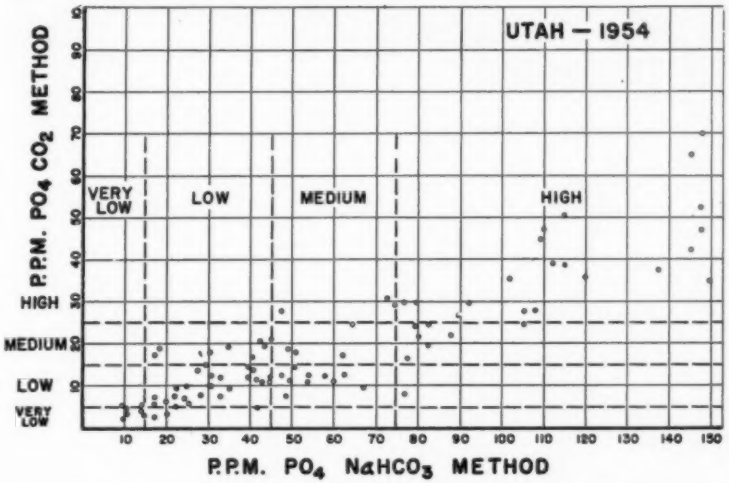

Figure 3.—This figure shows the parts per million of PO_4 from Utah soils as determined by the CO_2 method and calibrated along the left side of the chart and the $NaHCO_3$ shown along the bottom of the chart. Note that although the parts per million is approximately three times as large when determined by the $NaHCO_3$ method as when determined by the CO_2 method, there is nevertheless a close correlation between the two.

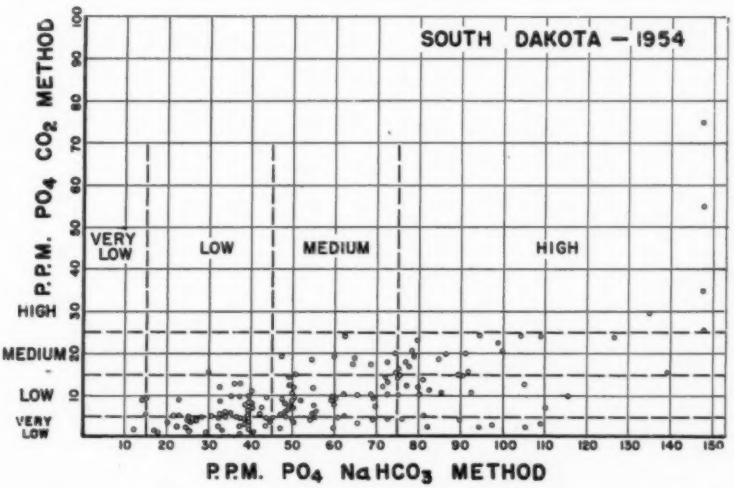

Figure 4.—This figure shows the parts per million of PO_4 from the South Dakota soils as determined by the CO_2 method and calibrated along the left side of the chart and the $NaHCO_3$ shown along the bottom of the chart. Note that in this figure there is not the close correlation of results by the two methods as there was from the soils samples taken in Washington, Idaho, and Utah.

Table 1.—Distribution of Phosphate Levels in Various Areas as Shown by Both the CO_2 and $NaHCO_3$ Extraction Methods.

Method of Analysis and Phosphate Level (PO_4)	Washington No.	%	Idaho No.	%	Utah No.	%	So. Dak. No.	%
Very Low								
CO_2 Method -0-5 ppm	0	0	7	11	10	12	52	32
$NaHCO_3$ Method 0-15 ppm	5	5	1	1	8	9	2	1
Low								
CO_2 Method 6-15 ppm	37	39	33	49	36	41	73	45
$NaHCO_3$ Method 16-45 ppm	38	40	34	50	33	38	56	35
Medium								
CO_2 Method 16-25 ppm	30	32	14	20	19	22	23	20
$NaHCO_3$ Method 46-75 ppm	26	28	17	25	18	21	58	36
High								
CO_2 Method—above 25 ppm	27	29	14	20	22	25	5	3
$NaHCO_3$ Method—above 75 ppm	25	27	16	24	28	32	46	28
Total Number of Samples	94		68		87		162	

Table 2.—Relationship Between Lack of Response to Phosphate in Field Trials and the Percentage of Soil Samples Showing Adequate Phosphate Levels.

Comparisons	Wash.	Idaho	Utah	So. Dak.	Total
No. of field tests with phosphate	68	52	77	49	246
% of tests giving response	66	71	69	73	70
% of tests giving no response	34	29	31	27	30
% of soil test with PO_4 in excess of:					
75 ppm—$NaHCO_3$ Method	27	24	32	28	28
25 ppm—CO_2 Method	29	20	25	3	16

phosphate level closely approached the percentage of field trials in South Dakota where no yield response was obtained.

The data in Table 2 show that the available PO_4 in soil samples was averaging about three times as high by the $NaHCO_3$ method as it was by the CO_2 method. Soil samples were classified as "very low," "low," "medium," or "high." The range of available PO_4 selected for each group classification by both methods of analysis is shown in Table 2. When all areas are considered, the $NaHCO_3$ method apparently classified available phosphate levels more accurately than did the CO_2 method. This was especially true in the South Dakota district where many of the soils are very heavy gumbo.

The data in Table 3 gives the number and percentage of soil samples falling in various phosphate levels. It also shows the relationship between phosphate response in field trials and phosphate levels. When soils were in the 'very low" class, 100 percent of the field trials showed a phosphate response. When soils were in the "high" classification or above 75 ppm of PO_4 as shown by the $NaHCO_3$ method, then only 33 percent of the field trials showed any response to added phosphate and this response was very limited when compared with the average response of three tons per acre, which was obtained on fields where phosphate levels were classified as "low."

Recommended Fertilizer Schedule

The recommended phosphate application has been varied according to the phosphate level as shown by the soil test. This recommendation varies from none on soils classed as "high" in available phosphorus, up to 120 pounds of P_2O_5 on soils classed as "very low."

Table 3.—Phosphate Level of Soil Samples Tested and the Relationship of Phosphate Level to Phosphate Response.

Comparisons	Phosphate Level of Soil Samples			
	Very Low 0-15 ppm	Low 16-45 ppm	Medium 46-75 ppm	High Above 75 ppm
No. of soil samples in each level	16	161	119	115
% of soil samples falling in each level	4	39	29	28
% of field tests showing yield response to phosphate at each of the phosphate levels	100	74	72	33
Magnitude of the yield response per acre	2.42 tons	3.05 tons	2.53 tons	.94 tons

(Note: Phosphate levels are in terms of ppm of available PO_4 as determined by $NaHCO_3$ extraction.

Summary

Data presented in this paper would indicate that in some areas of heavy soils such as around Belle Fourche, South Dakota, the $NaHCO_3$ method of analyzing for available phosphorus is more accurate than the CO_2 method. Available phosphate levels in terms of ppm of PO_4 run about three times as high in most soils when analyzed by the $NaHCO_3$ method as when analyzed by the CO_2 method. Consequently, where 25 ppm of PO_4 in a soil was set as the top limit where phosphate fertilizer would be recommended when the CO_2 method was used, the limit has been raised to 75 ppm of PO_4 when the $NaHCO_3$ method is used. When the available phosphorus in the soil was above 75 ppm, only 33 percent of the field trials showed a yield increase, and of those showing a response the increased yield averaged .94 tons per acre. On soils where the available phosphorus was not above 45 ppm of PO_4, 74 percent of the field trials showed a yield response and the response averaged 3.05 tons per acre.

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Beet Mosaic and Beet Yellows Virus Transmission by the Green Peach Aphid

EDWARD S. SYLVESTER[1]

For a period of years, vector-virus relationship studies have been in progress in many areas of the world, and much of this work has been with virus diseases of sugar beets. The knowledge that has been accumulated is still far from complete, but it is at a stage which allows for some speculation concerning the phylogeny of vector-virus relationships. The following remarks will be confined to a relatively narrow portion of the phylogenetic continuum which seems to be emerging within the aphid-borne viruses. However, it appears likely that the other vector-virus relationships will fit into the same general scheme.

In general, present day classification puts vector-virus associations into two broad, relatively inclusive, groups; namely, the *persistent* and the *nonpersistent*. The implications of the terminology are that the former are retained for long periods of time by vectors, while the latter are not.

Beet mosaic virus, in its vector association, might be cited as being typical of the nonpersistent group, while the yellow-net virus might be said to be representative of the persistent group. Yellows, in its vector-virus relationships, is neither typically persistent, nor is it typically nonpersistent. Being somewhat intermediate between the two extremes, it might be called *semi-persistent*. The resemblances and differences between these two viruses, *i.e.*, beet mosaic and beet yellows, perhaps can be best illustrated by taking up three fundamental phases of aphid transmission: acquisition, inoculation, and retention.

Acquisition

Beet mosaic is a virus that can be acquired by aphids within a few seconds of feeding on diseased tissue. The graph (Figure 1), illustrates a theoretical curve which might be derived from the published data (4, 5) on the acquisition threshold period of beet mosaic and the green peach aphid, *Myzus persicae* (Sulz.). It should be emphasized that the time scale is in *seconds*. As can be seen, between 5 and 10 seconds the insects begin to acquire virus. The probability of virus acquisition rises to a maximum in the 20 to 30 second range, and then, if the feeding period is prolonged, loss of infectivity occurs. This is of importance, since the usual interruption of a trial penetration by an aphid which has previously been fasted occurs in the 15 to 20 second range.

Recent evidence by Bradley (2) and others (1), indicates that the insects acquire such viruses as beet mosaic from the epidermal tissues of the plants, and that as aphids penetrate into deeper tissues, they begin to feed in areas which are relatively poor sources of virus. Thus, it would appear that beet mosaic is a virus which reaches the most favorable concentrations for insect transmission in the epidermal layers of the plant.

An examination of the limited data on the acquisition of beet yellows virus by the green peach aphid would indicate that the same type of curve

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[2] Numbers in parentheses refer to literature cited.

could be fitted, and such a graphic representation is seen in Figure 2. The main difference is in the time scale. With beet mosaic, the time scale was in *seconds,* while in yellows, the time scale was in *hours.* These data indicate that as aphids feed for a period of hours on a yellows infected plant, there is a gradual rise in the probability of virus acquisition until a maximum is reached between 12 and 24 hours. Extension of the curve is hazardous, and whether or not prolonged feeding on the diseased source will cause a gradual decrease in vector efficiency is not known at the present time. The only indications are from limited experiments where the performance of insects fed on a virus source plant for a single 24 hour period was com-

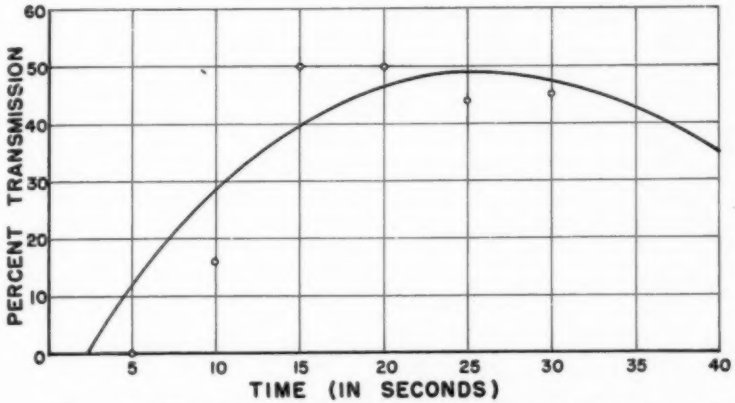

Figure 1.—Theoretical curve calculated from published data on the acquisition threshold period of beet mosaic virus and the green peach aphid. $\hat{Y} = 29.37 + 4.3\ (X - 50) - 0.08\ (X^2 - 1083.3)$.

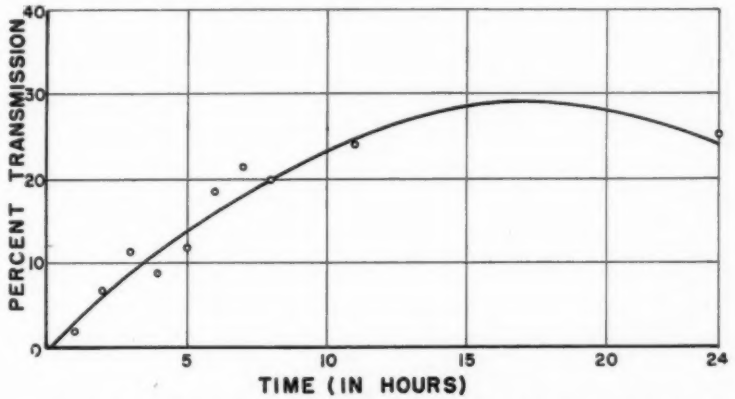

Figure 2.—Theoretical curve calculated from data gathered on the acquisition threshold period of the beet yellows virus and the green peach aphid. $\hat{Y} = 14.23 + 3.34\ (X - 6.55) - 0.095\ (X^2 - 84)$.

pared to that of insects fed on the same virus source plant for 2 consecutive 24 hour periods. In this case the 24 hour fed insects transmitted virus at about 30 percent efficiency, while the 48 hour fed insects transmitted virus at about 11 percent efficiency (41 infections out of 140 plants tested, versus 16 infections out of 140 plants tested, adjusted $X^2 = 12.68$, d.f. 1, $p = .001$).

However, using the 48 hour result in the calculation of the parabola, it is evident that the estimated parabola decreases too fast. However, the hypothesis that a parabolic curve, or some portion thereof, could be used to represent the manner in which the beet yellows virus is acquired by feeding green peach aphids has yet to be disproven.

Thus, it is quite possible that a similar pattern of virus acquisition exists for both the beet mosaic and the beet yellows viruses, except that the time scales are entirely different, one being in seconds, and the other being in hours. With this as a basis, it might be speculated that the acquisition of the mosaic virus is best when the aphid stylets are in the epidermal region, while acquisition of the yellows virus is best when the insects are penetrating into the mesophyll or mesophyll-phloem area. In any event, it would seem that in the field, the prevention of insects from acquiring beet yellows virus would be a much easier task than the prevention of the acquisition of beet mosaic virus by migrating alatae.

Inoculation

The inoculation threshold period of beet mosaic virus by the green peach aphid, like that of the acquisition threshold period, is a matter of seconds. The curve (Figure 3) rises rapidly to a maximum, and further increase in penetration time is of no benefit. The same type of curve (Figure 4) is applicable to data on the inoculation threshold period of beet yellows virus, but, as in the case of the acquisition period, the time scale is in hours. However, based upon the available evidence, the rapid

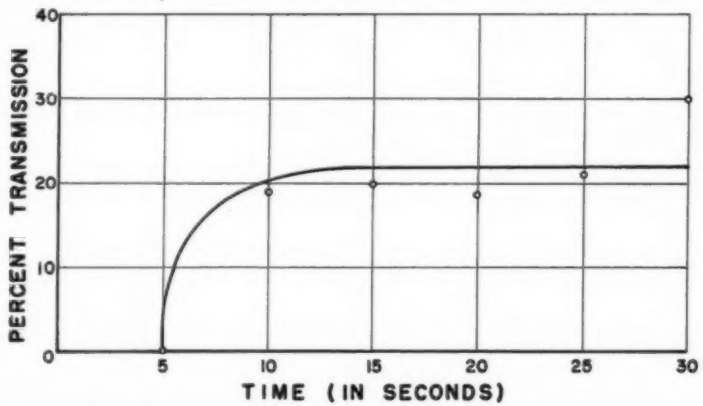

Figure 3.—Theoretical curve ($\hat{Y} = 1 - e^{-at}$, $a = 0.60$, t = seconds — 5) calculated from data published on the inoculation threshold period of the beet mosaic virus and the green peach aphid; 22 percent transmission was taken as unity.

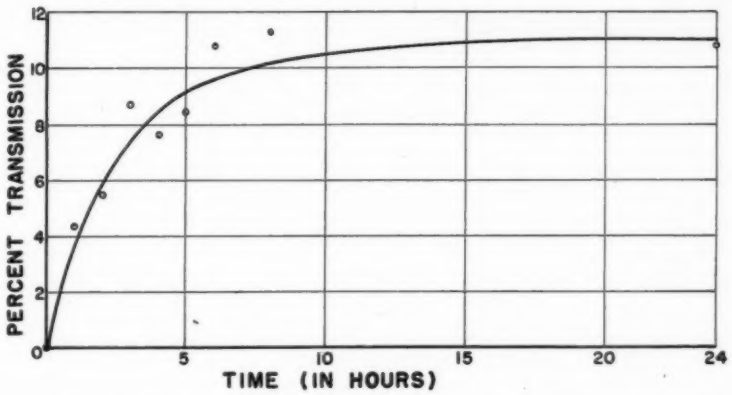

Figure 4.—Theoretical curve ($\hat{Y} = 1 - e^{-at}$, $a = 0.345$, t = hours) calculated from data gathered on the inoculation threshold period of the beet yellows virus and the green peach aphid; 11.44 percent transmission was taken as unity.

initial rise of the curve indicates that the inoculation threshold period is a matter of minutes, with a maximum efficiency in virus inoculation being reached in about 3 hours.

It would appear that the inoculation of virus is not as rigidly dependent upon a particular tissue as is acquisition, *i.e.*, the probability of successfully establishing an infection is not as precisely governed by specific tissue regions as is that of acquiring virus. This may mean that the virus when once introduced into a favorable tissue can survive with low levels of multiplication until such time as it is translocated to the more favorable regions for virus increase.

Virus Retention by Aphids

Since the beet mosaic virus is rapidly acquired and rapidly inoculated, it is not particularly surprising to find that the period of retention of a virus charge by an infective insect is brief. The actual time which a given aphid will retain a virus charge sufficiently large to insure infection depends to a considerable extent upon the treatment of the vector, *e.g.*, whether the aphid is feeding or fasting after acquisition, as well as the temperature. However, for practical simplicity, beet mosaic is not retained by the green peach aphid for much more than a half hour. The data can be reduced to an exponential curve of the order $p = e^{-at}$ [3], and estimating the half-life from limited data gathered at Berkeley, it would place the half-life of beet mosaic virus in a feeding insect at approximately 5 minutes. This would mean that there is a 50 percent reduction in the probability of having an infective insect for every 5 minutes that it feeds on a healthy plant. A graphic representation of such data is given in Figure 5.

The same type of curve can be developed using the beet yellows virus and the green peach aphid, but here again the time scale is different. In

[3] In the equation, p = the probability of obtaining an infection, e is the base of natural logarithms, a is a constant, and t = time.

the case of the beet yellows virus, the half-life is approximately 8 hours, instead of 5 minutes, as is illustrated in Figure 6.

Thus, it can be seen that the basic type of relationship existing between the beet mosaic and the beet yellows viruses and the vector *Myzus persicae* (Sulz.) under the experimental conditions imposed, differs mainly in a quantitative way, rather than in a qualitative way. This is not a new concept. It has been suggested and advocated with various lines of reasoning by the English workers for a period of years, mainly K. M. Smith (3) and M. A. Watson (6). It must be remembered, however, that data are not

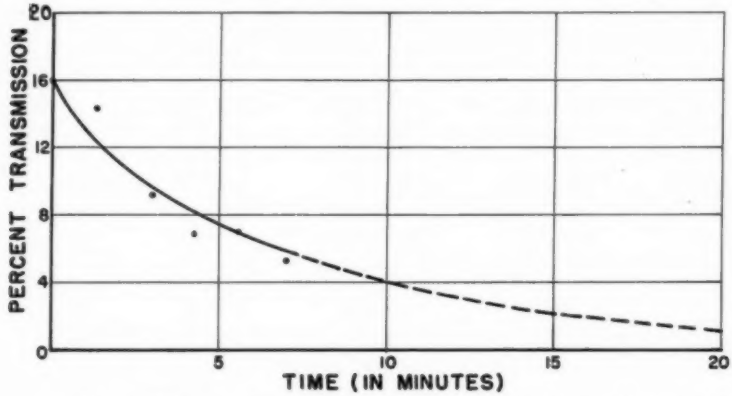

Figure 5.—Theoretical curve ($\hat{Y} = e^{-at}$, $a = 0.143$, $t =$ minutes) calculated to fit data published on the retention of beet mosaic virus by the green peach aphid. The curve was calculated to fit 16 percent transmission at zero time. The dotted portion represents extrapolation.

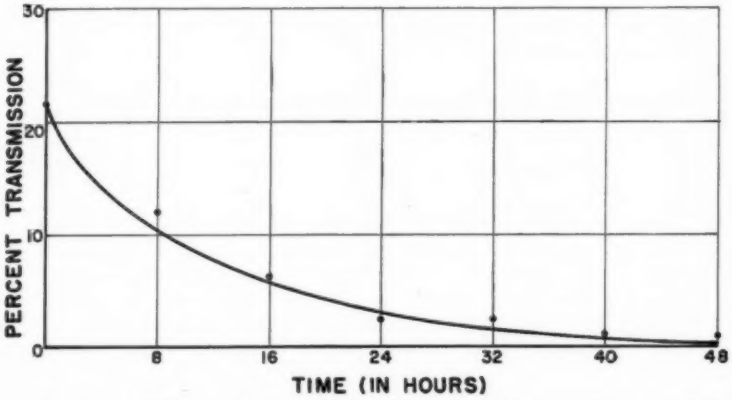

Figure 6.—Theoretical curve ($\hat{Y} = e^{-at}$, $a = 0.086$, $t =$ hours) calculated from data gathered on the retention of beet yellows virus by the green peach aphid. The curve was calculated to fit 22.4 percent transmission at zero time.

available to date which permit proper assessment of the limitations of the concept.

Speculating further, it might be suggested that the more dependent a virus has become upon a particular host plant, or the more specific are the demands of the virus for certain tissue regions, the more tenacious are the vector-virus relationships likely to be.

Beet mosaic, a virus which reaches maximum concentration for vector transmission within the epidermal tissues of the plant, but a virus which has not yet become specialized to the extent that it can be readily transmitted from plant to plant by wind-blown leaf contact, is still dependent upon insects for its transmission and prepetuation. Evolution (without any implied teleology) has admirably fitted beet mosaic virus to transport by means of aphids, since these insects apparently find their host plants largely by chance and random probing in epidermal tissues of plants. Favoring the transmission are the low degree of vector specificity, the rapid acquisition during a trial feeding penetration, and the rapid inoculation by a similar feeding attempt. What is lost in advantage by the inability of the virus to survive for long periods within the vectors is gained in the lack of vector specificity.

Beet yellows virus, one which apparently requires a slightly different tissue for optimum multiplication and survival in transmission concentrations, presumably the mesophyll or the mesophyll-phloem tissue, is more dependent on insect vectors for survival. In this case, the vector-virus relationships, *i.e.*, acquisition, inoculation, and retention, are less ephemeral. Since the vectors, to acquire the virus, must penetrate more deeply into the tissues of the plant and since only those vectors which can use beet for a host plant for their own benefit are likely to penetrate the beet tissue for long periods, the vector specificity found in beet yellow is likely to be stronger. However, in the case of beet yellows virus, the greater restriction of vector specificity is compensated by an increase in the time which the virus is retained.

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The Design of a Vacuum Pan

EDGAR B. COLE[1]

This paper deals specifically with the design of a mechanical forced circulation calandria vacuum pan. The coordinated design of the calandria and the forced circulation impeller resulted in a pan of exceptional performance. An improved type of barometric condenser and functional instrumentation further enhanced this pan's operation.

A complete detailed discussion of vacuum pan design would require considerably more space and time than can be allotted for this paper. Therefore, only one phase of design will be dealt with in detail, viz., the coordinated design of the calandria and the forced circulation impeller.

Our Company has in four of its factories a total of twelve mechanical circulation calandria vacuum pans. Nine of these pans are original equipment which were converted to the forced circulation type by installing Webre circulators and the Webre system of sugar boiling control. Three of these pans are new pans which were designed by the author. One new pan of the latest design is being built this year for next fall's campaign. By next fall we will have three pans of the new design for boiling white sugar and one for boiling intermediate sugar. Of the nine earlier forced circulation pans, three are boiling intermediate sugar and six are boiling raw sugar.

A detailed study of the proportions versus the operating characteristics of the original nine forced circulation pans leads us to draw up the following general specifications:

1. Of the total finished strike volume, not more than 25 percent to 30 percent should be included in the tubes, center well, and in the space below the bottom tube sheet.

2. The proportions of the pan should be such that the depth of the finished strike above the top tube sheet should not be more than half the internal diameter of the pan.

3. In order to maintain an acceptable production rate, and to enable us to use low pressure vapors not over 15 pounds pressure, there should be approximately two square feet of heating surface for every cubic foot of finished strike volume.

4. If we are to meet the three preceding specifications, the tube lengths must be kept as short as possible which of necessity dictates tubes of a smaller diameter than usual in current practice.

5. More circulation than available in the nine original pans was desired and a velocity in the tubes of two feet per second during the initial boiling down of the graining charge was a design goal.

6. The standard Byers type of barometric condenser was generally satisfactory but it was felt that an improved design was necessary to give closer

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[2] Numbers in parentheses refer to literature cited.

temperature control of the pan and to reduce the water consumption of the condenser.

7. A piston-type dry vacuum pump with a displacement in cubic-feet-per minute of not less than the strike volume of the pan was necessary to give fast accurate temperature control of the pan.

8. A coordinated, compact, and functional instrument system was desired which would automatically control the vapor temperature in the pan, the fillmass temperature and/or the fillmass tightness in the pan, and the rate of boiling by controlling the flow of steam to the pan.

9. Last but not least, all other secondary operations by the sugar boiler should be made as convenient and free of exertion on the part of the sugar boiler as possible enabling him to concentrate his efforts toward improving the quality of the finished strike.

Items 4 and 5 of the general specifications, i.e. the design of the calandria and the forced circulation impeller will now be discussed in detail.

The strike volume and the boiling schedule of the new pan were specified by our operating department to be 1,100 cubic feet of white fillmass every two hours. Space limitations limited the diameter of the pan to 12 feet-6 inches. A study was made of four different tube sizes and four calandria sections were designed. Table 1 lists the features of these four calandria for comparison.

Fluid flow characteristics were calculated for each of the four calandria for the following conditions: Case I, Water at 75° C., 0° Brix, density 60.9#/cu. ft., Viscosity 0.383 Centipoises; Case II, Liquor at 75° C., 82.5° Brix, density 87.0#/cu. ft., Viscosity 300 Centipoises; Case III, Fillmass at 75° C., 90° Brix, density 90.2#/cu. ft., Viscosity 5,000 Centipoises. For each of the three different fluids five liquid velocities in the tubes were assumed, i.e., 0.5, 1.0, 1.5, 2.0, and 2.5 feet per second. Thus, a total of 60 different sets of operating conditions were calculated and plotted.

Fluid viscosities for the liquor and the fillmass were arrived at by a series of approximations. These were later checked against measurements

Table 1.—Calandria Proportions.

Pan Diameter—12'-6". Well Diameter—4'-9". Total Strike Volume—1,100 cubic feet. Heating Surface—2,540 square feet.				
Tube Diameter, Inches	2½"	2¾"	3"	4"
Tube Diameter, Feet	0.188	0.209	0.230	0.313
Tube Length, Inches	31	33	34	41
Tube Length, Feet	2.57	2.75	2.85	3.40
Number of Tubes	1680	1416	1240	750
End Area of Pan, Ap.	122	122	122	122
Area of Well, Aw.	17.75	17.75	17.75	17.75
Aw./Ap., Percent	14.55	14.55	14.55	14.55
Area Tube Sheet, Ats.	104.25	104.25	104.25	104.25
End Area Tubes, At.	46.3	48.7	51.6	57.7
At./Ats., Percent	44.4	46.7	49.5	55.3
Vol. below Top Sheet	316.3	334.4	349.4	409.0
Vol. above Top Sheet	783.7	765.6	750.6	691.0
Vol. below/Vol. Pan, Percent	28.8	30.3	31.8	37.1
Depth of Strike, Feet	6'-5"	6'-4"	6'-2"	5'-10"

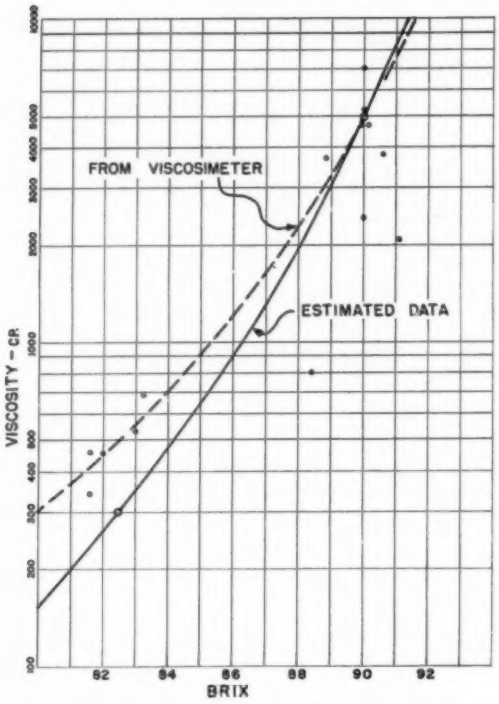

Figure 1.—Apparent Viscosity vs. Brix at 75° C.

taken in the pan with a Bendix Ultrasonic Viscosimeter. The original assumptions of viscosity were surprisingly reliable. Figure 1 shows a curve of apparent viscosity versus brix at 75° C. as measured by the Ultrasonic Viscosimeter, and the curve of assumed viscosities at 75° C.

Reynolds Numbers ($Re = VD\rho/\mu$) for all flow conditions were calculated and Fanning Friction Factors were determined from a chart showing Re vs. f. This is shown in Figure 2. This figure and the method of calculating fluid flow and pressure drops in the tubes are from W. H. McAdams (1)[2], Heat Transmission, Chart V, pages 99 to 134. In Figure 2, I have indicated the regions for the several flow conditions. As will be noted, the flow conditions in the tubes for water are definitely in the turbulent flow region, while the flow conditions in the tubes for the liquor and the fillmass are definitely in the streamline flow region. For the center well the flow conditions for water are very turbulent; for the liquor the flow conditions are just in the turbulent flow region; flow conditions for the fillmass are well into the streamline flow region.

Head losses due to fluid friction in the tubes and well were calculated from the typical Fanning Equation (2) $F_v = fV^2 \frac{(2L)}{(gD)}$ where F_v is the head loss in feet of the flowing fluid at given conditions, f is the Fanning

Friction Factor from Figure 2, V is the fluid velocity in the tubes, L is the length of the tube in feet, D is the internal diameter of the tube in feet, and g is the acceleration of gravity, 32.2 feet/sec./sec.

Head losses due to enlargement and contraction of the liquid entering and leaving the tubes and of the liquid entering and leaving the center well were calculated from the following equation (3): $F_e = \frac{(V_1 - V_2)}{2g}$ and $F_c = \frac{KV_2^2}{2g}$, where F_e and F_c are enlargement and contraction losses in feet of the flowing fluid respectively, V_1 is the velocity of the fluid leaving the tube, V_2 is the velocity of the fluid entering the tube, g is the acceleration of gravity, and K is a function of A_2/A_1 as given in Figure 47, page 122 in McAdams (4).

The data from the 60 sets of fluid flow conditions are so voluminous that no attempt will be made to present all these data in this paper. However, the next four figures amply illustrate in graphical form the highlights gleaned from the tabulated data.

Figure 3 illustrates the friction losses F in feet of fluid against the quantity in GPM circulating through the calandria at a velocity of 2-feet per second in the tubes. F_{total} is the sum of the fluid friction, fluid friction in the tubes F_{vt}, fluid friction in the well F_{vw}, enlargement and contraction losses in the tubes F_{eet} and the enlargement and contraction losses in the well F_{eew}.

Note that F_{eet} and F_{eew} are the same for all three different fluid conditions. Closer inspection of the formula for arriving at these losses will show that the losses are dependent solely on the velocities in the well and in the tubes and are independent of the viscosity and the density of the fluid. Note, also, that F_{eew} is of considerable magnitude, and in the case of water it represents the major loss. In the case of the liquor F_{eew} is also of consider-

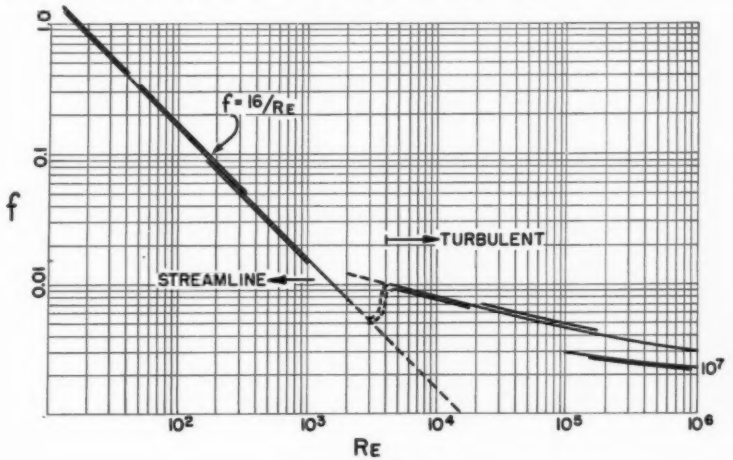

Figure 2.—Re vs. f.

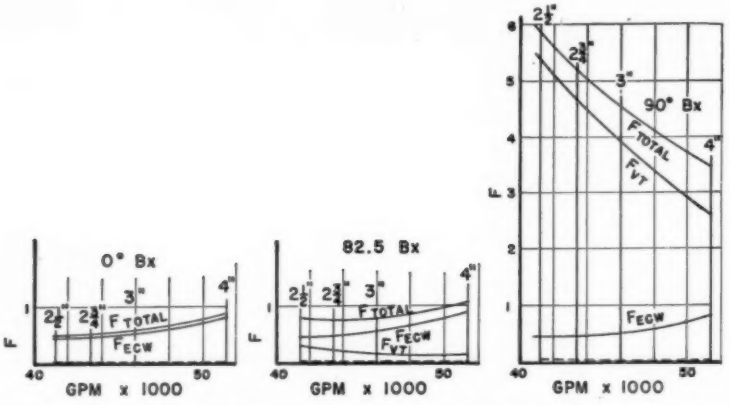

Figure 3.—F, in feet of liquor vs. Q, in gallons per minute. (At tube velocity of 2 feet per second.)

able importance. In the case of the fillmass, F_{ecw} merely modifies the total friction loss. As would be expected, the fluid friction loss in the tubes F_{vt} is small for water, of more importance for the liquor and of major importance for the case of the fillmass. The fluid friction loss in the well as almost so small as to be negligible. Figure 3 illustrates clearly the importance of well size and design as it affects the total head losses encountered in circulating liquor and fillmass in a vacuum pan calandria, especially for forced circulation vacuum pans.

Figure 3 indicates that when one designs a calandria for a vacuum pan, the designer must calculate the enlargement and contraction losses for the center well as well as the friction losses due to viscous flow in the tubes. The enlargement and contraction losses for the tubes and the friction losses in the well due to viscous forces can usually be disregarded as their combined effect rarely will amount to more than 1 percent of the total friction losses for the calandria.

Figure 4 illustrates the total head loss H in the calandria in feet of liquid versus the quantity of liquid circulating in GPM. This figure shows the case for the three different liquids, for the four tube sizes, and at velocities in the tubes of from ½- to 2-feet per second. This figure clearly illustrates the effect of the tube size on head loss; i.e. for the case of water, the head loss at a given velocity is greater for the larger tubes; for liquor at 82.5° Brix there is no appreciable difference between the head losses for the different tube sizes; for a 90° Brix fillmass the head losses in the smaller tubes are appreciably greater than for the larger tubes.

After a careful study of all of the data and the preceding figures, we selected the calandria with the 2¾-inch diameter tubes for the final design. An impeller was designed to match the head loss characteritics of the calandria and the mechanical components of the circulator were designed.

Stepanoff's book, "Centrifugal and Axial Flow Pumps" (5), was used

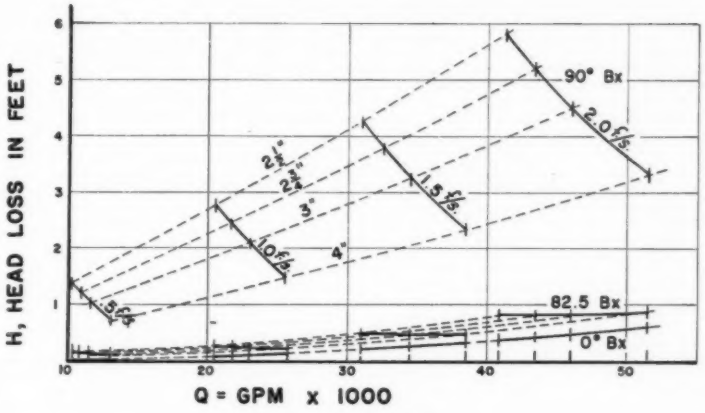

Figure 4.—H vs. Q.

as an aid and a guide in designing the impeller. Briefly the impeller can be described as a four blade, conical hub, axial flow impeller. The initial design conditions are: Fluid, Water; Q = 56,250 g.p.m.; Total dynamic head = 2.06 feet; R.P.M. = 84; Specific Speed = 11,600; Discharge blade angle 22½°; Impelling ratio 1.36.

The impeller as finally designed had a maximum blade tip diameter of 63 inches, an average or nominal blade tip diameter of 60 inches, and a minimum blade tip diameter of 57 inches. The center well is 57 inches in diameter, and there is a conical guide ring surrounding the blade tips. Maximum hub diameter is 30 inches and is conical in shape reducing to 12 inches in diameter at the small end of the hub.

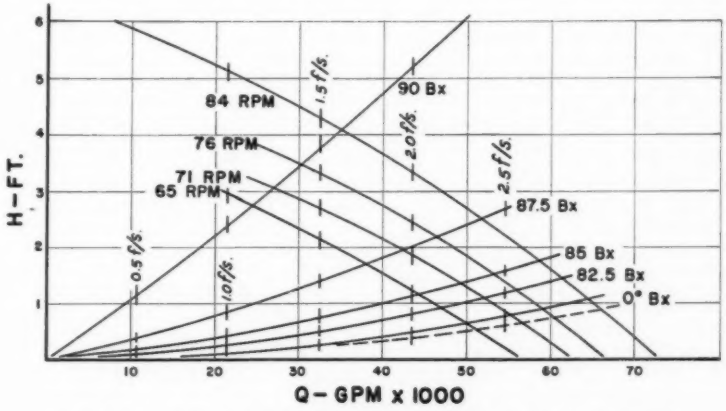

Figure 5.—H vs. Q for 2¾-inch tubes and H vs. Q for impeller.

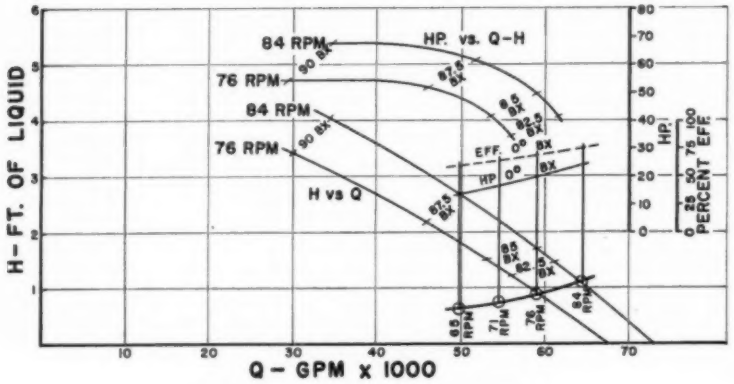

Figure 6.—Impeller characteristics.

Figure 5 shows a plot of the fluid flow characteristics of the 2¾-inch tube calandria versus the Q-H characteristics of the impeller. This figure is a special form of plot known to pumping engineers as a System Head Curve. For this figure 1 have calculated and plotted additional head loss curves for the calandria for the cases of fillmass at 85° Brix and for fillmass at 87.5° Brix. Q-H curves for the impeller at 84 rpm, 76 rpm, 71 rpm, and 65 rpm are plotted. Shown in dotted lines below the 0° Brix curve for the original pan is a plot of the head loss curve for 0° Brix for the three pans which were designed subsequent to this first pan. The later design is for a 13-foot diameter pan with 10 percent more tubes of 2¾-inch diameter and a length of only 30 inches. These later pans have the same total heating surface as installed in the original pan.

Test points are indicated for data taken at the various impeller speeds when the pan was filled with boiling water at 75° C. The head loss data for water as taken in the test agreed almost exactly with calculated design values.

This close agreement between the head losses calculated and found in test strengthened my confidence in the method of calculation. Therefore, I calculated the impeller efficiencies for water at the four impeller speeds and applied these efficiencies to the cases for liquor and fillmass. Later tests at the four impeller speeds for liquor and fillmass showed remarkably close agreement between the total horsepower required and the calculated total horsepower. Agreement was within 3 percent at a fillmass Brix of 90°.

Figure 6 shows a plot of Q vs. H for impeller speeds of 84 rpm and 76 rpm. Also shown are calculated total horsepower curves for 84 rpm and 76 rpm.

Initial operation at 84 rpm indicated that there was considerable power surging during the tightening of the strike; this suggested that cavitation was taking place at the impeller blades. Therefore, we reduced the speed

of the impeller to 76 rpm and eliminated the power surging. There was no indication that the performance of the pan suffered from this speed reduction.

Sugar-boiling operations at the lower speeds of 71 rpm and 65 rpm seemed to indicate that at these lower speeds the uniformity of sugar crystal sizing suffered. This was observed visually on the viewing screen of the Sucroscope and was verified by the increase in CV of the screened sugar samples produced at these speeds. The spread in crystal sizing appears to come about during the first half of the boiling of the strike. Therefore, we feel that the maximum circulation rate which will not produce cavitation during the tightening of the strike is necessary, inasmuch as it produces a more uniform crystal size during the important early phases of the strike when the grain is being formed.

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Galactinol-Weight Relationships in Breeding for Resistance to the Sugar Beet Nematode

J. F. Swink and R. E. Finkner[1]

The control of the sugar beet nematode (Heterodera schachtii) has become a serious problem of universal interest wherever sugar beets are grown. It has been felt that the best solution of this problem would be resistant varieties.

Progress reports of breeding for resistance to this pest have been given by Rietberg (4, 5)[2] and Swink (6). The breeding procedures used were to index and then to select the best appearing plants which were exposed to a severe infestation of nematodes.

Breeding resistant varieties would be easier if certain chemicals were known which would keep the eelworms from entering and feeding on the sugar beet roots. In 1922 Baunacke (1) suggested the possibility of isolating some chemical substance in the root secretions which would stimulate the cysts to hatch. Wood and Serro (7) made qualitative tests on concentrated root diffusates. They found three chemicals i-inositol, galactinol and glutamic acid which constituted the major portions of the exudate from nematode host plants.

Bauserman and Olson (2) tested various pure chemicals with respect to their influence on the hatching of the eelworms from the cysts. They concluded that galactinol, glutamic acid, glycine, and sucrose appeared to enhance the emergence of eelworms from cysts.

Chemical determinations of many of the above mentioned compounds have been made on strains which were phenotypically selected as being slightly resistant to nematode. As a result of the analysis in 1954, Finkner and Swink (3) reported an interesting galactinol-yield relationship.

The 1954 test was conducted on material that had been selected for tolerance to nematode in previous years. The test was set up in a triple-lattice design of 16 selections with single row plots 15 feet long.

The selections in the replicated plot test were very severely damaged by nematodes and many lines were nearly completely eliminated. However the data showed a definite differential reaction among the selections for yield under conditions of high nematode infestation.

The most interesting observation coming from the data of this test was the inverse association of galactinol with yield. The same relationship also was true when the three different strains from the border rows were sampled.

Hybrid XXIII appeared extremely susceptible to nematode and because of its high galactinol content this strain was chosen as a susceptible check for further tests.

Methods and Materials

The best roots from the 1954 plot tests were saved as mother beets. These were planted in the greenhouse for seed production before the

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[1] Station Superintendent and Chief Plant Breeder, respectively, American Crystal Sugar Company, Rocky Ford, Colorado.

[2] Numbers in parentheses refer to literature cited.

galactinol-weight relationship was discovered. The plants were allowed to interpollinate at random, but the seed was harvested by individual plant (M lines).

The seed production was quite limited from some individual plants, therefore, the number of plots planted varied from one up to nine plots. All of these seed lots, including 13 plots of the susceptible check, Hybrid XXIII, were planted at random in the 1955 nematode nursery. The plot size was single rows, 20 feet long, and all beets at harvest time were sampled for chemical analysis.

Results and Discussion

Good stands were obtained in the majority of the M lines and check. However, the growing conditions were not as favorable in 1955 as in 1954 because of drought conditions, especially in the latter part of the season. If the growing conditions had been more desirable a greater spread probably would have developed between the selections and the check. The check, however, appeared good throughout the growing season.

The yields were very low in all sections as shown in Table 1. However, it was noted that the relationship of galactinol and yield was much the same as was found in 1954.

Table 1.—Average Yield, Chemical Content and Number of Roots from Two or More Plots of Different Selections Grown in a Nematode Nursery.

Pedigree Number	Description	Lbs. Beets Per Plot	Percent Suc.	Percent Gal.	Percent Raff.	Total No. Plots	No. of Beets
4-3	Nursery Selection of 52-413	12.43	14.97	.030	.097	3	13.00
1-13	Line 3458-2	11.50	15.65	.045	.070	2	19.00
1-9	Line 3458-2	9.90	15.75	.035	.095	2	17.50
1-15	Line 3458-2	9.30	15.60	.045	.125	2	13.50
1-1	Line 3458-2	9.00	15.17	.040	.063	3	12.33
2-2	Line 3461-2	7.05	13.60	.040	.110	2	11.00
52-413-6	Field Selection of 52-413	6.90	13.20	.068	.084	5	7.00
52-413-2	Field Selection of 52-413	6.33	12.78	.076	.079	9	12.89
52-413-5	Field Selection of 52-413	6.10	10.15	.065	.055	2	15.50
8-4	Line 3493-1	5.33	14.77	.117	.097	3	15.00
Check	Hybrid XXIII	4.65	11.12	.078	.079	13	13.62
1-3	Line 3458-2	4.63	14.57	.100	.103	3	12.33
2-1	Line 3461-2	3.93	14.17	.080	.117	3	7.33
1-16	Line 3458-2	3.60	14.65	.100	.085	2	10.50
4-4	Nursery Selection of 52-413	2.94	13.60	.104	.106	5	3.80
	General Mean	6.91	13.98	.068	.091	3.9	12.29

The major part of the selections in this test were from individual roots from strains which ranked high in the 1954 test. Although the seed of these M line selections were all open pollinated, they tended to group closely to one another when they were from the same parent.

For example, the grouping of the "1" M lines which ranked 2nd, 3rd, 4th, and 5th were all from selection 3458-2. Two other M lines from this same parent selection ranked low. The "M" line progenies from the commercial field selection of 52-413 all ranked together around the general mean.

Figure 1.—Three top ranking progenies from the parent root 3458-12. Left to right: 1-15, 1-13 (in front of person) and 1-9.

The big exception to this trend was the "4" M lines. Selection 4-3 was the top ranking selection while its sister line 4-4 was the bottom ranking selection. Some segregation also should be expected in this material as all of it was open pollinated seed.

Three of the top yielding "1" lines from the parent root 3458-2 are shown in Figure 1.

The degree of tolerance of some of the selections expressed under extremely heavy infestations of nematode are shown.

Table 2 shows the results of some of the selections where only one plot was available for harvest. Again it brings out the same trend of galactinol and yield as mentioned in the previous discussion.

Table 2.—Yield, Chemical Content and Number of Roots from Single Plots of Different Selections Grown in a Nematode Nursery.

Pedigree Number	Description	Lbs. Beets Per Plot	Percent Suc.	Percent Gal.	Percent Raff.	No. of Beets
1-4	Line 3458-2	16.7	15.5	.020	.120	20
4-1	Nursery Selection of 52-413	15.7	14.5	.020	.050	13
8-1	Line 3493-1	10.6	14.3	.040	.130	11
1-10	Line 3458-2	4.5	16.5	.050	.120	5
1-7	Line 3458-2	2.5	16.9	.060	.080	4
1-12	Line 3458-2	1.8	15.5	.100	.150	3
8-2	Line 3491-1	1.6	15.1	.070	.130	2
52-413-4	Field Selection of 52-413	1.6	16.6	.010	.130	1
3-1	Line 3461-3	1.1	15.7	.070	.090	2
4-2	Nursery Selection of 52-413	0.6	13.9	.150	.120	1
1-5	Line 3458-2	0.4	12.3	.160	.130	1
1-6	Line 3458-2	0.4	11.6	.170	.110	1
	General Mean	4.79	14.87	.077	.113	5.33

The number of beets per plot in this table played a large part in the yield of each selection. The rank in yield very closely corresponds to the total number of beets harvested. The galactinol ranking falls into line very well, with the exception of one line 52-413-4. The fact that only a single root remained at harvest time no doubt has caused that misplacement. However, this root was very outstanding.

Summary and Conclusions

An inverse association between weight of beets and galactinol content has been found during the last two years of testing nematode selections in a diseased nursery. This would indicate that galactinol may be of value as a chemical characteristic in selecting beets resistant to this pest.

Because of these findings further tests of selections for various amounts of galactinol content are being conducted.

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Sampling of Sugar Beets for the Processing Laboratory

ROY TERANISHI, ROBERT L. PATTERSON AND HARRY S. OWENS[1]

The variation of sugar concentration in different parts of the sugar beet root has been reported by several workers. Further study has been made of this variation because of the necessity of having reliable sugar analyses on beets used for experimental purposes.

Data obtained by Urban (1)[2] and Floderer and Herke (2) indicate that the sugar concentration in the beet is at its maximum at the region of maximum diameter, then decreases slowly with the taper of the root. Data found by Ludecke (3) indicate that this tendency is not followed by some beets but that the sugar concentration is at a maximum in the region below the largest diameter zone. Fort and Stout (4) have found that there is relatively low sucrose concentration in the core portion of the beet with sucrose increasing to its highest value in the outside two-thirds portion of the beet but then dropping to a low value in the outer one-eighth inch. Fort and Stout point out that this variation in composition may have a decided effect on analytical results.

Experimental

Since the reported analyses did not show very large differences, it seemed that there would be some manner of sampling individual beets that would avoid the variations.

Plugs were taken from a single beet diagonally down from the zone of largest diameter towards the tip. By this procedure it was hoped that the samples would be from the zone of highest concentration and thus would avoid the large variations. But the analyses from one beet were as follows: 9.9%, 10.1%, 11.0%, 9.9%, 10.4%, 9.0%, 11.0%, 11.0%. These results led to a more detailed study of how large the variations are in individual beets grown in this area.

Our initial studies were made by discarding the crown and cutting the beet root into three thick disks. Each of these disks was cut into concentric rings. Two samples for analyses from these rings were taken from diametrically opposite positions. Figure 1 illustrates how these zones were numbered. Table 1 is an example of the analyses obtained from 1600- to 2600-gram beets from Manteca and Woodland, Calif., which were stored from four to six weeks.

Table 1.—Analyses of Sectioned Beets.

	1	2	3
I	14.6%	13.2%	10.7%
	16.6	13.3	10.6
II	16.6	13.6	12.6
	16.5	13.6	12.1
III	16.9	14.3	13.2
	17.5	16.0	13.2

These data are in accord with those obtained by Ludecke (3), but such large differences have not been reported.

[1] Chemists, Western Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture, Albany 10, California.

[2] Numbers in parentheses refer to literature cited.

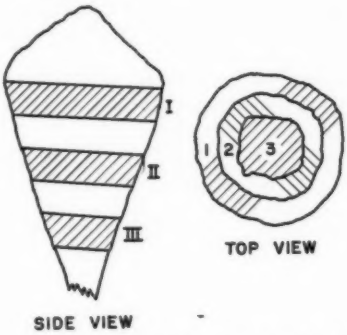

Figure 1.—Sectioning of Sugar beet root.

A more detailed study was made by paring 26-gram samples consecutively from the skin towards the core of cross-sectional disks about three centimeters thick. Care was taken to note which sample was composed mainly of parenchymous or of conductive tissues. As shown in Figure 2, a surprisingly large difference in sugar concentration was found in the two types of tissue of fresh beets, with the conductive tissues having more sugar. This observation was verified with beets from Brawley and Swingle,

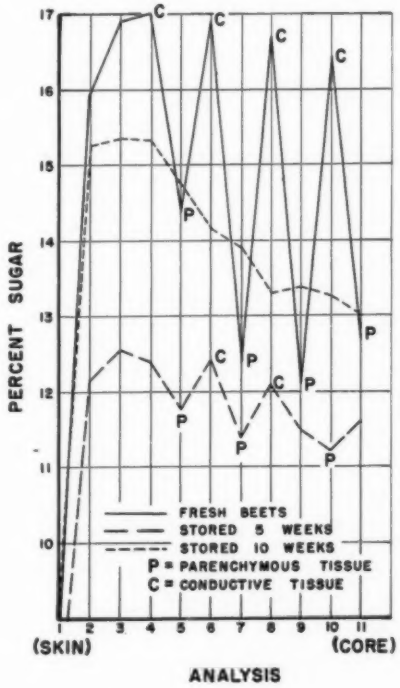

Figure 2. — Sugar concentrations of cross section of sugar beet root.

California. The largest difference observed was 12.5 percent in the parenchymous tissue with 17.0 percent in the adjacent conductive tissue, shown in Figure 2. This finding of difference of sugar concentration in the two types of tissues is in accord with that of Schneider and Hoffman-Walbeck (5), but they do not report as large a difference as we have found. Perhaps this smaller difference can be explained by the fact that they used beets that weighed 400 to 600 grams, whereas ours weighed from 1500 to 2000 grams. Also, it was observed that the concentration differences lessened after several weeks of storage. It was found that the sugar concentration in the center of the beet decreases with time to give a very good verification of the trend previously reported (4).

The very large differences in the different parts of the beet make it very difficult to obtain uniform samples from a beet. This is especially true of unsymmetrical beets because there is bunching of the tissues in certain sections. The most satisfactory method of obtaining uniform samples is to cut the beet into cossettes and to mix the cossettes thoroughly. This technique was used for samples used in finding conditions for the cold digestion Sachs-Le Docte method of analysis and for finding the percentage of sugar in beets used in experiments.

In the analyses reported here, the Sachs-Le Docte method of analysis for sucrose was used. The sugar beet, with the crown and tip removed, was cut into cossettes $\frac{1}{8}$x$\frac{1}{8}$x$\frac{3}{4}$ inches with an Urschell dicer, and then these cossettes were thoroughly mixed by hand in a stainless steel pan. Samples of 26 grams of these cossettes in 179.1 ml. of 5° Brix lead acetate were ground in electrical blenders. Conditions for the cold digestion technique were found by grinding for 1- and 5-minute periods, with extraction periods of 1/6, 1/2, and 3-hour periods. These data, given in Table 2, indicate that a 5-minute grinding period and 10-minute extraction period are satisfactory.

Table 2.—Analyses Used in Determining Conditions.

Grinding periods	Extraction periods			
	1/6 hr.	1/2 hr.	1 hr.	3 hrs.
1 min.	16.4%	16.6%	16.7%	17.3%
5 min.	17.7%	17.6%	17.5%	17.6%

It was noted in some of the analyses, especially those of the skin and of the pulp, that the filtrate colored upon standing enough so that it interfered with the reading. This coloration was greatly diminished by filtering in a nitrogen atmosphere. This filtration was accomplished by filtering into a suction flask with a slow stream of nitrogen coming in the side arm.

One hundred and fifty to 200 pounds of beets used in experiments are cut into cossettes and are mixed thoroughly in a cement mixer. Analyses of such cossettes result in sugar percentages as the following: 15.4, 15.2, 15.2, 15.2, 14.8, 15.3, 15.3, 15.6, 15.5, 15.2, 15.3, 15.0. The larger variation is probably due to poorer sampling from the longer cossettes and from larger differences because of the presence of the crowns and the tips. Analyses of cossettes which were cold, 2°-5° C., over a long period of time to see if there would be an appreciable sugar loss are shown in Table 3.

Table 3.—Analyses Showing Sucrose Retention in Storage.

	Initial	6 hr.	24 hr.	48 hr.	72 hr.
Sugar percentage	14.7%	14.6%	14.7%	14.7%	14.6%*

*These values are average of 5 to 6 analyses.

From these data it was concluded that cold cossettes could be cut and mixed and kept for 6 to 8 hours to give a uniform source for experimental purposes.

Summary

It is very difficult to plug beets to give a representative sample of the sugar concentration because of the variation in different parts of the beet.

The conductive tissues of the fresh beet root have a much higher sugar concentration than the parenchymous tissues. In a stored beet, the core has a lower concentration than the zone near the skin.

It was found that cossettes could be cut, mixed, and kept for 6- to 8-hour periods, if kept cool, to give a uniform source for experimental purposes.

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The New DdS Silver Slope Diffuser

HAROLD F. SILVER[1]

Several years ago the Danish Sugar Company (De danske Sukkerfabrikker) began experiments in continuous diffusion, hoping to develop an apparatus that would be simpler than the continuous diffusers then available in Europe and America. Among those assigned to the project was Mr. H. Bruniche-Olsen, a young Danish engineer, who conceived certain ideas that were finally embodied in a full-size diffuser of approximately 1,200 tons daily capacity at the Kolding slicing station (1)[2]. This machine, called the "DdS" Diffuser (using the initials of the sugar company), proved to be much simpler in construction than previous continuous diffusers and achieved very satisfactory operating results. Subsequently, a larger machine was built and installed at the Assens factory, and in 1954 a machine of 2,200 tons capacity was installed at the Saxkjobing factory.

During the 1953 campaign in Denmark, the operation of the Kolding and Assens machines was witnessed by the writer, who became interested in the possibilities of this new diffuser. A contract was later consumated between the Danish Sugar Company and Silver Engineering Works, Inc., whereby the latter took over the manufacturing and sales rights in the western hemisphere. It was evident to the writer that American sugar engineers would desire machines of greater capacity and lower retention time than had been developed in Denmark. Silver Engineering Works, Inc.,

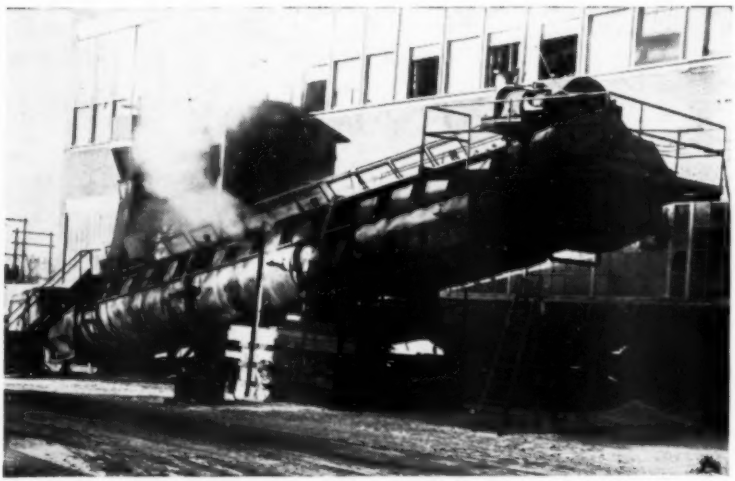

Figure 1.—Pilot diffuser at Gering, Nebraska.

[1] President, Silver Engineering Works, Inc., Denver, Colorado.
[2] Numbers in parentheses refer to literature cited.

therefore, undertook to build a pilot diffuser incorporating certain changes in design that, it was hoped, would make possible the higher tonnages and shorter retention time.

The pilot diffuser consisted essentially of a sloping trough, shaped to fit around two intermeshing scrolls revolving outwardly at the top. The cossettes entered at the lower end and were scrolled to the upper end, where they were removed by a pulp dewatering wheel. The water entered at the upper end and percolated through the cossettes by gravity to the lower end, where the juice was withdrawn through a fine perforated screen, which was kept clean by a pair of rotating scrapers. A photograph of the machine in elevation is shown in Figure 1, and a cross section in shown in Figure 2.

The Great Western Sugar Company made available its Gering, Nebraska, plant for the experimental operation, and the pilot machine was installed for the 1955 campaign. The diffuser was fed by a separate slicer with a separate weighing device and could, therefore, be operated independently of the regular factory Robert battery. Complete controlling and recording instruments were installed, and arrangements were made with the laboratory to take hourly samples of pulp and juice and to make periodic checks of juice purity and pH.

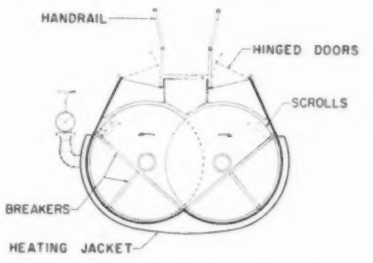

Figure 2.—Section through pilot diffuser.

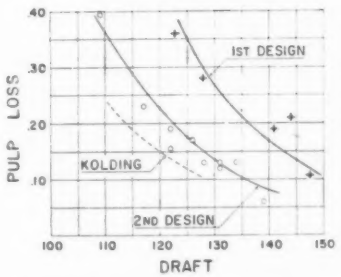

Figure 3.—Draft and pulp loss—first trial runs.

The first operation of the pilot diffuser established that the volumetric capacity had been increased in the Silver design, but the sugar recovery was disappointing. The results are shown as "First Design" in Figure 3. After a few days of operation, the diffuser was shut down and changes were made in the construction of the breaker bars. The machine was then put into service again, with greatly improved performance as to pulp loss and draft. The results of this operation are shown as "Second Design" in Figure 3.

In the Danish machines the scrolls were made up of spaced-concentric, helical bands built as continuous flights. In the Silver version of the machine, the scrolls were built similarly, except that the scrolls were interrupted and separated by breaker bars. One section of one of the scrolls had been supplied with a perforated aluminum plate, in place of the helical bands and this appeared to function much better than the rest of the scroll. The machine was again shut down and the spaced bands were replaced with steel perforated plates. Steel was used instead of aluminum

because it could be more readily installed by welding. After the machine was again put into service, it was obvious that the results had been significantly improved. The pulp loss and draft were not only lowered to the range of the Kolding machine, but the capacity was further increased, so that the machine on a volume basis operated at a rate approximately double that achieved in Denmark. The retention time of the cossettes was found to be only 40 to 45 minutes, or about half that of the Kolding machine. The juice retention time was figured to be 30 to 35 minutes.

It was concluded that the general design of the machine was now satisfactory, and arrangements were made to determine the optimum slope of the diffuser. The machine had been built for ready adjustment as to slope and at the time of installation was set on a slope of approximately 9 degrees. Mr. Bruniche-Olsen had originally experimented in Denmark with a slope of 1 in 10 but had later settled on a slope of 1 in 7 (approximately 8 degrees) as being more satisfactory. The writer believed that a somewhat steeper slope might yield better results. The machine was raised to 11 degrees slope and an immediate improvement in the results was noted.

After a few days of operation, the slope was again raised, this time to 12 degrees; but the pulp loss increased and the power exceeded reasonable requirements. The slope was lowered to the 11 degree setting and the results improved. The slope was then reduced to 10 degrees, but the results appeared to be somewhat poorer. The slope was now increased to 10½ degrees and the results improved to about the same range as attained at 11 degrees. It appeared that an angle of 10½ degrees to 11 degrees was the optimum slope of the diffuser. Figure 4 shows the operating results for the "Third Design" at the 9 degree, 11 degree, and 12 degree slopes. The curve for Kolding is also shown for purposes of comparison. The Kolding diffuser was operated with the return of pulp-press water, whereas, the pilot diffuser had no such return. The curve for Kolding has, therefore, been adjusted to what it would have been had there been no return of press water.

An additional benefit was gained by the changes made in the third design. Previous to the installation of the perforated plates the purity of the raw juice from the pilot diffuser was found to be consistently below that of the factory juice from the Robert battery. This appeared to be

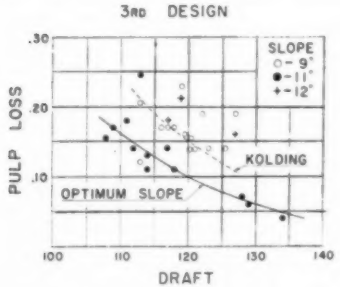

Figure 4.—Draft and pulp loss at various slopes

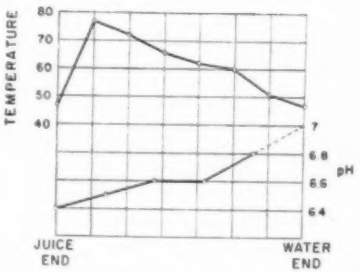

Figure 5.—Temperature and pH through diffuser.

caused by the hanging up of pulp on the scroll arms between the helical bands, which pulp sometimes would turn black before it finally worked itself loose. After the installation of the perforated plates, there was no further hanging up of pulp, and the purity of the raw juice from the pilot diffuser was always either equal to or higher than the factory raw juice.

The pilot diffuser was heated with two steam jackets wrapped around the trough; one at the lower end extending up about 60 percent of the length, and another at the upper end extending down about 30 percent of the length. Figure 5 shows the temperature range throughout the length of the machine and the pH determinations at various points in the machine. The maximum temperature of 77 degrees was reached near the lower end of the machine and gradually tapered off to 51 degrees at the control point at the upper end. It was found that if the temperature at the upper control point was maintained above 51 degrees the pH would be well above 6, but if the temperature dropped below 51 degrees there was a drop in pH to dangerous levels. No formaldehyde or other bactericide was used in pH control. Laboratory tests showed that the lactic acid content of the raw juice from the pilot diffuser was less than for other continuous diffusers in the Great Western factories and about the same as for Robert batteries.

The Danish Sugar Company had found it desirable to use very large cossettes (15-division knives) to get proper circulation. The initial run of the Silver pilot diffuser was made with cossettes from 23 division knives, but it was found that the machine would also operate satisfactorily with cossettes from regular 46 division knives set at 1¾ millimeters up and 1¾ millimeters back.

During part of the campaign the pilot diffuser operated with badly frozen and partly rotten beets without apparent difficulty. While it may be expected that there will be some reduction in capacity with rotten or mushy beets, it was the opinion of the factory superintendent and his staff that deteriorated beets could be processed much more easily in the DdS Silver Slope Diffuser than in the Robert diffusion battery.

The pilot diffuser was built with scrolls 54 inches in diameter and 45 feet long. The over-all length of the machine was 57 feet, and the over-all width was 12 feet. The scrolls were driven with two 7½-horsepower motors, and the pulp dewatering wheel with a 2-horsepower motor. A speed-changing device was used to experiment with various scroll speeds. Up to 1.1 RPM there was no appreciable tendency for foam to form, and the machine handled about 550 tons of beets per day without the use of foam-breaking oils. At higher speeds and capacities, a small amount of oil was required. It appeared that about one gallon of Balab, Steffens Type, cut with kerosene, would suffice for each 200 tons of beets. When automobile crank-case drainings were substituted for the Balab, about five times the quantity of oil was required. An interesting observation was made in the use of these oils. It was found that the Balab, a vegetable oil compound, seemed to travel mostly with the juice, and, therefore, had to be added near the middle of the diffuser to be most effective. On the other hand, the crank-case drainings, a mineral oil, seemed to travel with the cossettes, and had to be added at the lower end to give the best results. At the top speed of 1.4 RPM, a maximum capacity of 753 tons of beets per day was reached, and for several

hours at a time an operating rate of over 800 tons was recorded. It is believed that a rated capacity of about 650 tons of beets per day should be assigned to the pilot diffuser. Based upon this rating, commercial machines up to 4,000 tons capacity have been projected, as shown in Table 1.

Table 1.—Projected Diffuser Sizes and Capacities.

Size (Scroll Dia.)	Floor Space Required (Approximate)	Connected Horsepower	Capacity Tons Per Day
78"	14 Ft. x 60 Ft.	40	1300
90"	16 Ft. x 62 Ft.	50	1750
102"	18 Ft. x 64 Ft.	60	2200
114"	20 Ft. x 66 Ft.	80	2700
126"	22 Ft. x 68 Ft.	100	3300
138"	24 Ft. x 70 Ft.	120	4000

The 1955 campaign averages of pulp loss and draft for most of the factories of the large beet sugar companies in the United States are plotted as points on a chart in Figure 6. Also shown on the chart for comparison is the curve of operation of the pilot DdS Silver Slope Diffuser. This indicates the large potential of sugar and coal saving that may be made with this new diffuser. It is the most simple and the most accessible apparatus yet devised for continuous diffusion. It should have a very long life, as witnessed by the fact that the maximum thickness of metal removed from the shell of the pilot machine by erosion and corrosion was only .008 inch in over 60 days of full operation.

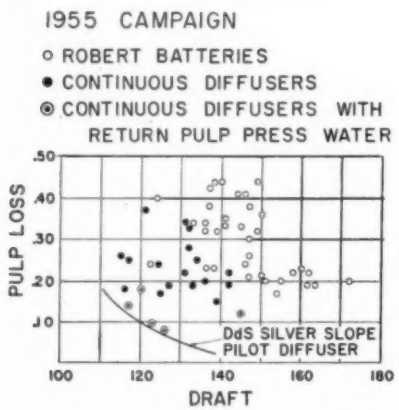

Figure 6.—Draft and pulp loss campaign results—American factories.

The first commercial diffuser of this type has been ordered by The Great Western Sugar Company for operation at its Eaton, Colorado, factory during the 1956 campaign. This could well inaugurate a new era in diffusion, with the DdS Silver Slope Diffuser becoming the new standard of the sugar industry.

References

(1) BRUNICHE-OLSEN, H. Evaluation of non-cell-divided continuous diffusers III. Sugar Magazine, Vol. 49, No. 6, June, 1954.

Minutes of the Ninth General Meeting American Society of Sugar Beet Technologists

The business session of the Ninth General Meeting of the American Society of Sugar Beet Technologists was called to order by the Society's president, Mr. P. B. Smith, at 10:45 a.m. on Tuesday, January 31, 1956, in the Peacock Court of the Hotel Mark Hopkins, San Francisco, California.

The chairman of the meeting, Mr. Smith, announced that the purpose of this meeting was to hear committee reports, the report of the secretary, the report of the treasurer, and to transact what other business may be appropriate to this meeting.

The chairman called for the reading of the minutes of the Eighth General Meeting held in Denver, Colorado, on February 4, 1954. Upon motion made, seconded, and unanimously carried, reading of the minutes was dispensed with.

The chairman then requested the desire of the meeting regarding the reading of the report of the secretary. Upon motion made, seconded, and unanimously carried, reading of the report of the secretary was dispensed with since such report was to be published as part of the minutes of this meeting. The report, as prepared for the meeting, is noted below and becomes a part of these minutes.

Report of the Secretary

Membership by States and Countries—1954-1955

	Company	Individual		Company	Individual
Washington, D. C.		4	Ohio	1	11
Arizona		3	Oklahoma		1
California		115[1]	Oregon		5
Colorado	1	105[2]	Pennsylvania		1
Connecticut		1	South Dakota		4
Delaware	1	1	Utah		47
Florida		1	Washington		6
Idaho		23	Wisconsin		2
Illinois		15[3]	Wyoming		6
Indiana		2	Belgium		1
Iowa		3	Canada	1	32
Kansas		3	Chile		1
Louisiana		1	Denmark		5
Maryland		7	England		4
Michigan		33	Haiti		1
Minnesota		11	Hawaii		1
Missouri		1	Iran		1
Montana		18[4]	Ireland		2
Nebraska		14	Netherlands		2
New Jersey	1	0	Pakistan		1
New Mexico		2	Spain		1
New York		11	Sweden		2
North Dakota		1	Uruguay	1	2
				6	514

Totals include deceased members as follows:

[1] G. J. Daley, Clarence Nielsen

[2] G. W. Deming, J. A. Summerton, N. R. McCreery

[3] A. S. Gale

[4] Charles Mann

This report indicates that there was a gain of 48 members during the biennium 1954-55.

Respectfully submitted,

JAMES H. FISCHER, *Secretary*

The chairman then requested that the report of the treasurer be read. The treasurer thereupon briefly reviewed receipts and disbursements during the biennium January 1, 1954, through December 31, 1955. The report as prepared for this meeting is noted below and becomes a part of these minutes.

Report of the Treasurer

Herewith is submitted the treasurer's report covering the two-year period, January 1, 1954, through December 31, 1955.

RECEIPTS

Beet Sugar Development Foundation	$ 6,000.00
Book Sales	2,069.20
Membership Dues	2,630.00
Registration	1,290.00
Banquet Tickets	1,853.00
Abstracts (other than in registration fee)	31.50
Postage	151.51
Reprints	1,023.00
Page Overage	590.52
Certificates	30.50
Contributions to meeting expense (includes 1956)	2,090.00
Miscellaneous	475.00
	$18,234.23
Cash Balance, January 1, 1954	6,280.19
	$24,514.42

DISBURSEMENTS

Meeting Expense	$ 4,427.35
Publications	10,239.10
Postage	756.16
Reprints	1,332.61
General Office Expense	923.37
Return of Registration Fees	18.00
Certificates	13.77
Miscellaneous	67.50
	$17,777.86
Cash Balance, December 31, 1955	6,736.56
	$24,514.42

Respectfully submitted,
JAMES H. FISCHER, *Treasurer*

Upon motion made, seconded, and unanimously carried, the report of the treasurer was accepted unanimously and ordered placed on file.

The chairman then announced that normally a report of the Resolutions Committee was read at this meeting. Since it was not possible to prepare such report in advance of the meeting, he requested that the Resolutions Committee prepare such report and that it be submitted to the secretary. The secretary was instructed to include this report in the minutes of the Ninth General Meeting. The report of the Resolutions Committee is reported herewith and becomes a part of these minutes.

Report of Resolutions Committee

BE IT, AND IT IS HEREBY RESOLVED, that a vote of thanks and appreciation be given all those who have made this Ninth General Meeting an outstanding success. Special acknowledgment is due the following:

1—Our dynamic president, P. B. Smith, and our efficient secretary, James H. Fischer, and other officers, the various committees, and the ad-

visory council. We wish to especially commend the secretary for the improved printed program for this meeting.

2—The general program chairman, H. P. H. Johnson, and the six section chairmen who arranged such an excellent program.

3—The general arrangements committee, composed of Alden Stock, Lester Holmes, R. J. Tingley, and Hugh Melvin for the performance of the numerous tasks confronting this committee.

4—Herbert Bush and his able assistants at the registration desk.

5—James Mussatti, J. Earl Coke, and H. B. Hass for their contributions to the General Session.

6—The Western Sugar Producers, Inc. for handling the publicity.

7—The following sugar companies and supplying firms for their contributions which made available certain entertainment and other conveniences so vital for an enjoyable meeting:

American Crystal Sugar Company
Ames Harris Neville Company
Anaconda Copper Mining Company
Arrowhead Lime & Chemical Company
Bemis Brothers Bag Company
Blackwelder Manufacturing Company
Braun-Knecht-Heimann Company
Brea Chemicals Company
Crown Zellerbach Corporation
Dorr-Oliver, Incorporated
El Dorado Limestone Company
Gladding, McBean and Company
Great Lakes Carbon Corporation
Haas Ammonia & Fertilizer Company
Henry Disston Division
Holly Sugar Corporation
Ogden Iron Works Company
Shell Chemical Corporation
Silver Engineering Works, Incorporated
Spreckels Sugar Company
St. Regis Sales Corporation
Stauffer Chemical Company
Stearns-Roger Manufacturing Company
Union Sugar Division Consolidated Foods Corporation
Wilbur-Ellis Company
Western Phosphates, Incorporated

8—The management and employees of the Mark Hopkins Hotel for their splendid cooperation during the meetings.

9—The Resolutions Committee regrets to report the death of eleven of its members:

M. R. ALLEN
L. J. ARNOLD
G. J. DALEY
G. W. DEMING
A. S. GALE
CHARLES MANN
N. R. MCCREERY
CLARENCE NEILSON
H. S. OWENS
J. A. SUMMERTON

C. R. WING

A brief biographical sketch of each of these members is incorporated in this report and the committee hereby requests that copies be sent to the next of kin with an expression of sincerest sympathy.

H. W. DAHLBERG
ORIN A. HILLS
C. E. CORMANY, Chairman

February 2, 1956
San Francisco, California

The above biographical sketches appear following these minutes as an "In Memoriam."

The chairman then announced that a ballot had been sent to the members of the Society on which each member could indicate his decision regarding a by-law change which would establish a "Best Paper Award." He further announced that this change was received favorably by the Society and that the following addition would be made to the by-laws.

Best Paper Award. This award shall be given to the Society member who has presented the most outstanding paper at the General Meeting. Such award shall be made within a reasonable time following the General Meeting and will be acknowledged by a published announcement from the Society headquarters. The awardee will be presented an appropriate citation and/or prize which may later be provided.

One year in advance of the biennial meeting for which it is to function, the President of the Society shall appoint a committee of six members, one representing each section, to be called the Best Paper Award Committee, which shall choose the winner on the basis of the following: Scientific and practical value—50%; Preparation of manuscript, charts, slides, etc.—35%; Presentation—15%. Prior to action by the above committee and immediately following the final meeting of each section, the chairman will submit in writing not more than five candidates selected for subject matter (rated 1, 2, 3, 4, or 5 with No. 1 being the highest rating) and presentation (rated a, b, c, or d for excellent, good, fair, poor, respectively).

Papers eligible for the award must be in the hands of the Section Chairmen prior to the close of the General Meeting and shall have been prepared and presented according to directions provided for such meeting.

The chairman then announced that a Publications Committee consisting of G. D. Manuel, chairman, Harvey Brewbaker, Frank Rawlings, and P. A. Reeve had been appointed for the purpose of determining the advisability of changing the Society publication from a Proceedings to a periodical. He then asked Mr. Manuel to report the findings of his committee.

Mr. Manuel then reported the deliberations of his committee and to facilitate the changes recommended, proposed a by-law change to read as follows:

Article 5. Publications. The official publication of the Society shall be a quarterly, the *Journal of the American Society of Sugar Beet Technologists*, to be issued each April, July, October, and January. An Editorial Board of three members appointed by the President shall have final authority on all matters covering the publication, editing, and printing of the Journal. The Secretary shall serve as an ex-officio member of this Board.

All papers presented at the General Meeting or suitable abstracts thereof shall be presented to the section chairmen, who with their appraisal of the technical and historical value of the papers submitted will pass these on to the Editorial Board. The Editorial Board shall have jurisdiction over the release of papers and abstracts for use other than in the Journal, and papers submitted to the Board shall become the property of the Society.

No commitment for expenditures of the funds of the Society for publications can be made without the approval of the Executive Committee.

Following the reading of the above proposed change, Mr. Manuel moved that it be adopted. Upon motion thus presented, seconded, and unanimously carried, the above change was accepted as proposed.

The chairman then announced that the Physiology Section had qualified as an official section of the organization. Article 4 of the constitution states that "Additional sections may be organized on a tentative basis for the purpose of facilitating presentation of papers with the approval of the Executive Committee. Upon evidence of ability to develop and execute a well-organized section program for two consecutive general sessions of the Society, Sections so organized may acquire permanent status upon approval by the Executive Committee and Advisory Council." The chairman further announced that a vote of the Society was necessary to change the constitution so that Article 5 would include "Section F. Physiology." Upon motion made, seconded, and unanimously approved, Section F became an official section of the organization.

The chairman then announced that a committee had been apointed to tally the votes cast for officers of the Society for the biennial period 1956-57. Announcement of the successful candidates was to be made during the banquet on February 3 and for the purpose of record are listed below:

President, Austin Armer; Vice President, F. N. Rawlings; Secretary-Treasurer, James H. Fischer; Advisory Council—West Coast Area, C. W. Bennett, G. D. Manuel; Intermountain Area, Bion Tolman, Harold E. Ellison; Eastern Slope Area, E. H. Hungerford, H. P. H. Johnson, C. M. Nicholson; Eastern U. S. Area, Grant Nichol, M. G. Frakes; Eastern Canadian Area, C. A. Neil; Western Canadian Area, Wesley Smith; At Large, Lyman Andrews, Vernal Jensen.

There being no further business, the meeting was declared adjourned at 11:45 a.m.

In Memoriam

Marshall R. Allen

1887-1954

Marshall R. Allen was born in Emerson Township, Gratiot County, Michigan. He had been connected with the sugar industry all his working life, commencing his employment with the Michigan Sugar Company as assistant superintendent of the Alma plant after his graduation from Michigan State College. Later he was plant superintendent at Michigan's Saginaw plant, at the Holland plant of the Holland-St. Louis Sugar Company, and at the Findlay, Ohio, plant of the Great Lakes Sugar Company. After three years in Canada, where he supervised the construction of a sugar plant, he returned to the United States to become general manager for the Great Lakes Sugar Company.

Mr. Allen passed away at his home in Highland Park, Michigan, on February 22, 1954, following a month's illness. Mr. Allen had been a member of the American Society of Sugar Beet Technologists since 1950.

L. J. Arnold

1890-1954

L. J. (Pat) Arnold was born in Salt Lake City, Utah, on November 4, 1890. He commenced work with the Utah-Idaho Sugar Company at Nampa, Idaho, in 1908 as a clerk-stenographer. He was later transferred to the Sugar City, Idaho, factory and in 1916 to the general office at Salt Lake City, as agricultural clerk. In 1922, he became factory office manager for the Gunnison Sugar Company and in 1933, was appointed agricultural superintendent for the Gunnison district, the position he held at the time of his death.

Mr. Arnold passed away at his home in Gunnison, Utah, on September 4, 1954, after more than 40 years' service in the beet sugar industry. Mr. Arnold was a member of the American Society of Sugar Beet Technologists since the society was formed and, in 1950, was presented the society's Forty-Year Veteran Award.

Gustave J. Daley

1881-1954

Mr. Gustave J. Daley obtained his engineering and chemical education at the University of Minnesota. He started his sugar career with the Great Western Sugar Company at Greeley, Colorado, in 1904 as assistant to the tare chemist. The next year he was transferred to Sterling as chief chemist, later becoming traveling chemist. In 1912, he became superintendent of the Brush, Colorado, factory and in 1916 was transferred to Fort Collins. In 1920, he commenced employment with the Holly Sugar Corporation as manager of the California district. During his management, the California district expanded by the acquisition of Anaheim, Los Alamitos, Alvarado, Tracy, and Hamilton City. He initiated the reconstruction of the Alvarado factory. In 1938, he retired from the employ of the Holly Sugar Corporation and busied himself with the operation of his square-mile farm near Woodland, California.

Mr. Daley passed away at Stockton, California, on December 10, 1954.

He had been a member of the American Society of Sugar Beet Technologists since it was founded and was a recipient of the Forty-Year Veteran Award in 1946. He had served as a member of the advisory council in 1938 and 1939.

George Warren Deming

1890-1955

George Warren Deming, agronomist, U. S. Department of Agriculture, was born March 3, 1890, at Fleming, Ohio. He received his B.S. degree from the University of Nebraska in 1918. In 1923, he was appointed assistant agronomist at the Colorado Agricultural Experiment Station and in 1931, assumed a position with the Sugar Corps Section of the USDA. Mr. Deming made many important contributions in sugar beet technology. His studies on the effect of variations in stand on sugar beet yield and quality have been highly significant. He conducted studies on hybrid vigor in sugar beets and was among the earlier workers to study the effects of blocking of beets by machine operation. He was also one of the early investigators on chemical weed control as applied to sugar beets. The Deming sugar beet inbreds, outcome of years and years of patient work, are unique in the field of sugar beet research in presenting an array of sugar beet germplasm for study and potential in sugar beet breeding. These inbreds have gained national and international recognition.

Mr. Deming passed away on June 17, 1955. He was a member of the American Society of Sugar Beet Technologists since 1939 and served on the advisory council in 1948 and 1949.

Albert S. Gale

1897-1954

Albert S. Gale was born in Oregon, Illinois, on May 23, 1897. He received his education through high school at Oregon, Illinois, and spent the early years of his business career in the same city. He attended Knox college in Galesburg, Illinois, for two years and transferred to the University of Chicago. Following brief service with the United States Army during World War I, he entered the banking business in Oregon, Illinois, until he joined the John Deere Plow Company of Moline, Illinois, in 1936. In 1942, Mr. Gale was transferred to the John Deere Wagon Works where he become personnel manager. During 1948, he became assistant manager and on November 1, 1949, he was promoted to general manager. As a manager of a leading manufacturer of sugar beet equipment, Mr. Gale contributed significantly to the rapid mechanization of the harvest of the sugar beet crop.

Mr. Gale died suddenly while at work on February 17, 1954. He was a member of the American Society of Sugar Beet Technologists from 1950 to the time of his passing.

Charles F. Mann

1892-1954

Charles F. Mann was born December 4, 1892, in Billings, Montana. He attended the Billings grade school and was graduated from the Billings high school in 1911. He joined the employment of the Great Western Sugar Company in 1911 and had been employed by the same firm since that date, serving as fieldman at Pompeys Pillar, Laurel, and Billings. In 1934, he was promoted to assistant manager. Mr. Mann was a lifelong resident of

Billings and was an enthusiastic supporter of the community activities. He was a member of the Billings Chamber of Commerce of which he served as a director, the Billings Masonic Lodge, the Midland Roundtable, the Pioneers of Eastern Montana, and the Billings Kiwanis club.

Mr. Mann passed away on Sunday, August 29, 1954. He was a member of the American Society of Sugar Beet Technologists since 1946.

N. R. McCreery

1882-1954

N. R. McCreery was born in Pennsylvania and grew up on a farm near Richmond, Kansas. Two years after his graduation from the Ottawa University business department in 1899, he came to Loveland to assume his first position with the Great Western Sugar Company as stenographer. He was proud to be an employee of the Great Western Sugar Company when the first crop was grown in the Loveland area for the first Great Western factory in 1901. In 1903, he was transferred to Longmont as assistant manager and became manager of the Longmont factory from 1908 until 1920, at which time, he was promoted to the Colorado district manager, a position he held until retirement in 1943. He was founder of the Great Western magazine THROUGH THE LEAVES which has been published without interruption since 1913. During retirement, Mr. McCreery served as president of the State Civil Service Commission, secretary of the Denver election commission, manager of the credit union of Denver City and County employees and held various jobs in the Denver treasurer and assessor's offices.

Mr. McCreery passed away on February 10, 1954. He was a member of the American Society of Sugar Beet Technologists since its beginning, was its vice president in 1936-37, was president in 1938-39, was chairman of the research coordinating committee in 1940-41, and was presented the Forty-Year Veteran Award in 1946.

Clarence Nielsen

1897-1955

Clarence Nielsen was born in Chualar in California's Salinas Valley on August 17, 1897. After graduating from engineering college, he spent a number of years in the Salinas Valley in active farming. In 1941, he was engaged by the Union Sugar Company as agricultural superintendent and soon thereafter was placed in charge of the company's agricultural activities in the Salinas Valley. He played an important part in the development of the Union Sugar Company's northern division which encompasses the Salinas Valley area. He was an ardent advocate for the beet sugar industry and was active in the affairs of the sugar industry. He had been elected chairman of the 1957 biennial meetings of the California Inter-Company Technical Conference.

Mr. Nielsen passed away suddenly of heart failure at his home in Salinas on April 18, 1955. Mr. Nielsen was a member of the American Society of Sugar Beet Technologists since 1948.

Harry S. Owens

1910-1956

Dr. Harry S. Owens was born in 1910 in Pocatello, Idaho, and grew up in that area. In 1931, he received a B.S. in chemical engineering from the University of Idaho. The following year, he conducted research at Columbia

University on a Borden Research Fellowship and continued as a graduate student until 1935, at which time, he received a Ph.D. in chemistry and chemical engineering. He then returned to the University of Idaho as assistant professor of chemistry and in 1942, joined the staff of the USDA research laboratory in Albany, California. During his years with the Western Utilization Research Branch, he was placed in charge of sugar beet research. In this capacity, he conducted studies of the composition of processing liquors. One phase of his work, concerned with organic acids, showed that a considerable portion of lactic acid was formed during diffusion. Application of methods of reduction of lactic acid have proved valuable to the industry. In the field of carbohydrate research, Dr. Owens earned national recognition and served on many scientific committees.

Dr. Owens died at his home in Berkeley, California, on January 22, 1956. Dr. Owens was a member of the American Society of Sugar Beet technologists since 1950.

John A. Summerton

1901-1955

Mr. John A. Summerton received his high school education at East Denver high school and entered the employ of the American Crystal Sugar Company immediately after his graduation in 1918. His first employment was that of a voucher clerk. Between this date and September 1952, when he became president of the company, he held many positions in the sugar industry which particularly fitted him for the office which he held at the time of his passing. Mr. Summerton was a staunch supporter of agricultural research and had a keen interest in all matters pertaining to agriculture. He played an important role in the construction of the Moorhead and Crookston factories of the American Crystal Sugar Company. Mr. Summerton was also president and director of the Ventura County Railway Company of California, a director of the United States Beet Sugar Association and the Denver National Bank.

Mr. Summerton passed away on April 14, 1955. He had been a member of the American Society of Sugar Beet Technologists since 1950.

Charles R. Wing

1884-1954

Mr. Charles R. Wing was one of the best known operating beet sugar executives in the industry. His career in the industry started at Lehigh, Utah, nearly 50 years ago, with the Utah-Idaho Sugar Company. With the Utah-Idaho Sugar Company, he was located at Garland, Utah, Elsinore, Utah, Nampa, Idaho, and Chinook, Montana. In 1925, he moved to Raymond, Alberta, where he became plant superintendent of the Raymond factory of the Canadian Sugar Factories Limited. He was superannuated after the 1949 factory campaign. Since that date, he had been carrying on private business interests and was directing the building operations for the L.D.S. church in Raymond. He was an active member of the L.D.S. church, having served in the British Mission and in the bishopric of the Raymond First Ward. He was a charter member of the Rotary club and was active in community life.

Mr. Wing passed away on August 28, 1954. He had been a member of the American Society of Sugar Beet Technologists and in 1946 was awarded the Forty-Year Veteran Award.

Meritorious Service Awards

These awards were presented at the Ninth General Meeting to those who have been outstanding in promoting the objectives of this organization and who have been active in its affairs. The Society hereby acknowledges the important role each has played.

CHARLES EVANS CORMANY

Charles Evans Cormany was born on a farm in Rural Retreat, Virginia, October 28, 1895. Raised on the farm, his education continued to include a B.S. from the New Mexico Agricultural and Mechanical Arts College and a M.S. from Cornell University. His first contact with sugar beets was in 1918 at the New Mexico Agricultural Experiment Station, State College, New Mexico. He was in charge of sugar beet agronomic work at Michigan State as an assistant professor and assistant in farm crops, following which, he became chief agronomist, agriculturist, Republic of Colombia, during 1928 and 1929. Returning from Colombia, he became associate agronomist with the Division of Sugar Plant Investigations, U. S. Department of Agriculture, in which capacity he participated in the early development of curly-top resistant varieties for the USDA. In 1935, Mr. Cormany became supervisor of the agricultural program for the Farmers & Manufacturers Beet Sugar Association and was charged with the responsibility of organizing their agricultural program. In 1936, he became chief agronomist for the Holly Sugar Corporation, at which time, he organized the beet seed breeding department for that company.

Mr. Cormany has been a shining example of active membership in the American Society of Sugar Beet Technologists since its first meeting. He was secretary-treasurer from 1942 through 1947 and became its president in 1952 and 1953. He has been a director and president of the Western Seed Production Corporation, a member of the American Society of Agronomy, Phi Sigma, Acacia Fraternity, Rotary Club, is a Presbyterian, and a Mason. He has been an author of numerous articles on sugar beet research. He resides at Sheridan, Wyoming, where he continues as chief agronomist for the Holly Sugar Corporation in charge of its beet seed breeding department.

NAHUM J. GIDDINGS

Nahum J. Giddings was born in Ira, Vermont, in 1883. His education includes B.S. and M.S. degrees from Vermont in 1906 and 1909 respectively and a Ph.D. in plant pathology from the University of Wisconsin in 1918. He was assistant botanist at the experiment station, University of Vermont from 1906 to 1909 and bacteriologist and head of the department, experiment station, West Virginia from 1909 to 1912. He was plant pathologist and head of department between 1912 and 1929 and was a professor in plant pathology between 1919 and 1929. In 1929, he became senior pathologist with the Division of Sugar Plant Investigation, U. S. Department of Agriculture. In this capacity, he specialized in plant viruses. He discovered that the curly-top virus is not a single entity but breaks up into strains, some of which are very much more virulent than others. He isolated many strains and determined their reactions. Most recently, he discovered a curly-top strain which is capable of injuring the most resistant strains of sugar beet now

known. He conceived the idea that one less severe strain could be used as an inoculum and, thereby, immunize one curly-top strain against another which, unfortunately, he later found to be only a hopeful dream. He played an important part in the testing of varieties being developed for curly-top resistance. His accomplishments were important to the development of present day resistant varieties.

Dr. Giddings' membership in the American Society of Sugar Beet Technologists dates from its first meeting and he is a member of numerous other scientific societies. He was vice president of the American Phytopathological Society in 1922 and has authored in excess of 50 important technical contributions in his specialty. He is now retired and resides at Riverside, California. He is continuing to spend time on some unfinished problems relating to the curly-top virus.

ASA C. MAXSON

Asa C. Maxson was born in a claim shanty on the prairies of western Minnesota in 1875. He attended grade schools at Dassel and Minneapolis, Minnesota, and high school at St. Cloud. At the age of 14 years, he moved with his family to a 4,000-acre grain farm in the Red River Valley of North Dakota where his father was resident manager. In 1898, he enlisted in the 13th Regiment, Minnesota Volunteers, and served with this regiment during the Spanish-American War and the Philippine Insurrection and as a scout in the Philippine Islands. After his return, he ran a dairy farm in Fenton County, Minnesota, and in 1910 commenced employment with the Great Western Sugar Company as supervisor of the experiment station at Longmont, Colorado. In 1912, he planted the first commercial acreage of sugar beet seed in Colorado. At the outbreak of World War I, he was charged with the mission of purchasing all available stocks of sugar beet seed in the eastern sugar beet areas for the Great Western Sugar Company. In 1919, he was given the responsibility of renovating and testing all available field sprayers for use in combating a serious webworm infestation in the Great Western territory. In 1922 and in 1924, he was loaned to the Amalgamated Sugar Company for study of the curly-top situation in southern Idaho, thus, laying the ground work for the white fly laboratory in Twin Falls. In 1926, he realized the advantage of crop rotation in combating nematode and eventually supervised the cropping on an excess of 4,000 infested fields.

Mr. Maxson was a member of the American Society of Sugar Beet Technologists at its first meeting and was prominent in developing the entomology and plant pathology section. He has authored many articles on sugar beets and has contributed an outstanding publication, "Insects and Diseases of the Sugar Beet," a book that is used as a world-wide reference. Mr. Maxson is now retired and resides in Longmont, Colorado.

JOHN C. OVERPECK

John C. Overpeck was born on a farm near Rosedale, Indiana, June 3, 1895, and received a degree of Bachelor of Science in Agriculture at Purdue University in 1917. He served nearly two years as a second lieutenant in the U. S. Army, 1917 to 1919, and received a M.S. degree from Ohio State University in 1920. Mr. Overpeck was an assistant professor of agronomy and assistant agronomist, University of Wyoming from 1920 to 1923 and became head of the department of agronomy, New Mexico College of Agriculture

and Mechanic Arts in 1923. He has held such position to date in conjunction with an appointment as agent, Sugar Crops Section, United States Department of Agriculture since 1924.

He is a member of American Association for the Advancement of Science (Fellow), American Society of Agronomy, American Society of Sugar Beet Technologists, American Association of University Professors, Kiwanis International, and is past president of the Kiwanis Club of Las Cruces, New Mexico.

Since the 1890's the New Mexico Agricultural Experiment Station had been studying the possibilities of sugar beet growing but, in 1923, the station began experiments on fall plantings to determine if the crop might be grown as a winter crop. It was noted that fall-planted beets produced an excellent harvest of seed the following summer. Within a few years, the various problems of date and rate of planting, thinning, fertilizing, irrigating, harvesting, threshing, and cleaning the seed were quite well worked out. The first commercial seed was grown in this area in 1926, and by 1938, practically the entire American sugar beet crop was grown from domestic seed.

FORREST VERN OWEN

Forrest Vern Owen was born August 27, 1899, and grew up on a farm in Weber County, Utah. In his youth, he learned the fundamentals of sugar beet culture by practical experience and derived a keen appreciation of the farmer's problems. His education includes a B.S. degree from Utah State Agricultural College at Logan, Utah, a M.S. degree from Oregon State College, and he was awarded a Ph.D. degree at the University of Wisconsin in 1926. He became biologist at the Maine State Experiment Station where he remained for four years and in 1930 joined the research staff at the Salt Lake City laboratory of the U. S. Department of Agriculture. He was immediately busy with the task of breeding for resistance to the curly-top virus. As this problem successively became of lesser importance through the development of varieties resistant to curly top, his interest turned to new breeding methods by the use of inbred lines and male-sterile hybrids. His long interest in the possibility of monogerm seed was bolstered when he learned of successful monogerm attempts in Russia. Knowing that the people who had been connected with this work were refugees in Germany, he initiated negotiations to bring the Savitskys to the United States. The importance of these latter subjects is reflected by the conspicuous part such reports occupy at the Ninth General Meeting of this Society.

Dr. Owen has been a member of the American Society of Sugar Beet Technologists since its first meeting, has been its vice president, has been chairman of the section on genetics and variety improvement, a member of numerous other committees and has served four biennial periods on the advisory council. He envisions great opportunities in the beet sugar industry through research and is confident that effective team work must be continued and broadened with each individual given an opportunity to express his own creative ability. Dr. Owen resides in Salt Lake City where, as principal geneticist, he is in charge of the Salt Lake City station of the U. S. Department of Agriculture.

Forty-Year Veteran Awards

These awards were presented at the Ninth General Meeting to those who have completed forty years of faithful service with the beet sugar industry of North America. The Society proudly pays honor to each of these awardees for the important part he has played in the development of the industry.

C. L. ABBOTT

A. J. BROWN

WILFORD Y. CANNON

J. T. DAVIS

WALLIS EDWARDS

J. GORDON ENGLISH

S. C. GADDIE

T. H. LACY

A. K. LOGAN

BRADLEY M. MARTIN

JAMES R. MASON

CARL KASPER SIELAND

ROBERT IRVING SMITH

WILLIAM EUGENE STRATFORD

H. S. VARNER

J. ARTHUR WOOD